SCREW COMPRESSOR PACKAGE TECHNICAL DATA

MYCOM
THE EXPERTS IN INDUSTRIAL REFRIGERATION

Bulletin: T-SU-G-001
Supersedes: New

BASIC PRINCIPLES OF SCREW COMPRESSOR

Introduction

The MYCOM V-Series and VR-Series Screw Compressor (referred to hereafter as the “V Series” and “VR Series”) are designed for single stage compression. They incorporate a variable volumetric Vi mechanism which allows these compressors to be adjusted readily for most operating conditions and a new rotor profile (“O”-profile) has been introduced to further improve performance.

V Series compressors are for electric motor application and VR Series compressors, which have integral speed-increasing gears are for gas or diesel engine drives.

General Structure

Screw compressor is classified as a positive displacement rotary type compressor. Suction gas is trapped in the clearance between the two mated rotors and pressure increased by decreasing volume. The compressed gas is then discharged as a high pressure gas.

All V and VR compressors have a similar structure. Please see V series screws below.

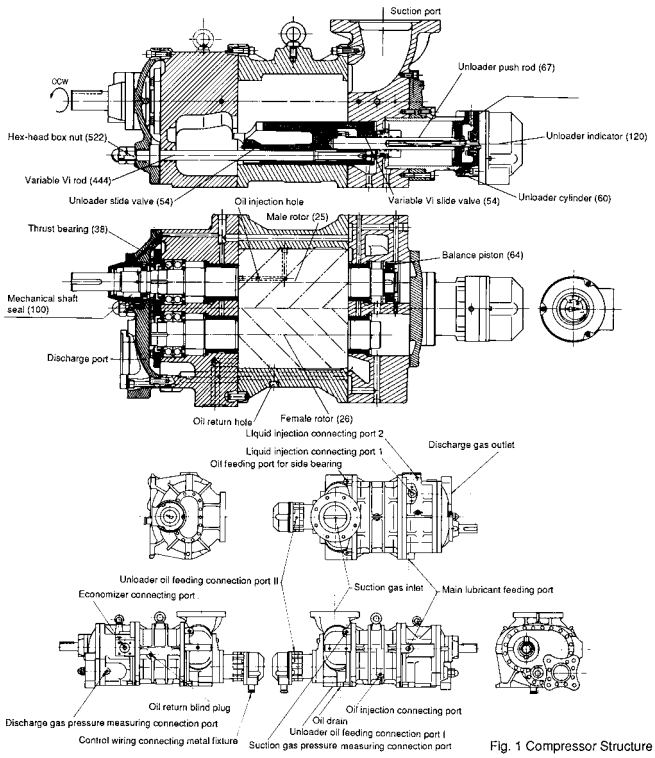
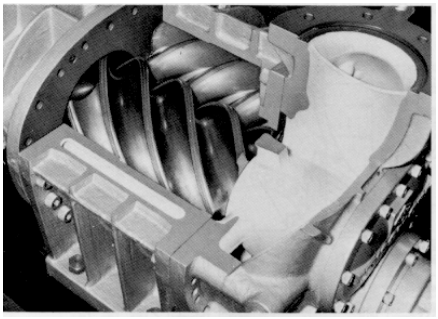


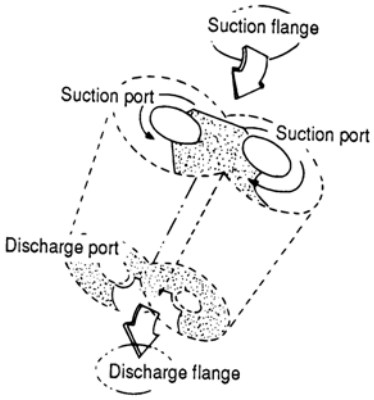
Fig. 1 Compressor Structure

General Structure of V Series

As shown below, a pair of mated helical gears (or rotors) is mounted in the compressor casing. The rotor having the four-lobe section is called the male (M) rotor while the one with the six-lobe section is called the female (F) rotor.

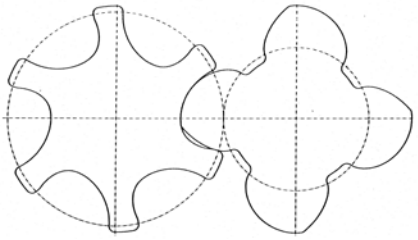


Screw Compressor cross sectional view

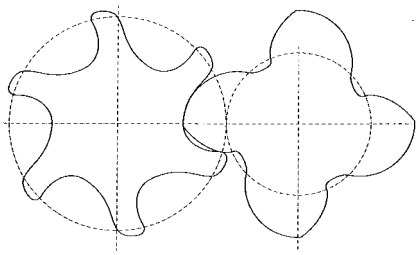


Rotor Rotation & the Compression Cycle

Compressor efficiency is related directly to the shape of the rotor lobes. In the case of the VR and V Series, the rotors have unsymmetrical Mycom O-profiles, which improve efficiency significantly. The new profile successfully reduces the size of the triangular blow-hole located between the compressor side casing and the two rotors by 60%, minimizing leakage due to the pressure difference.



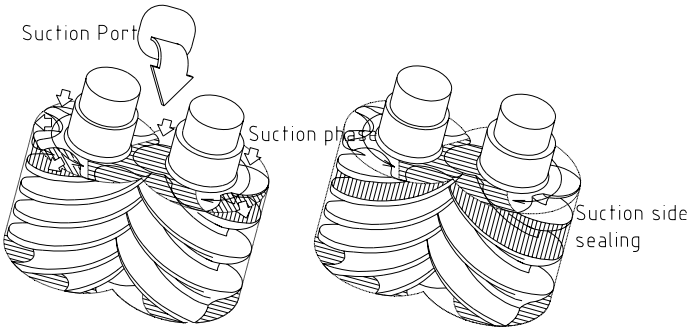
Old A-profile



New O-profile

Suction Stage

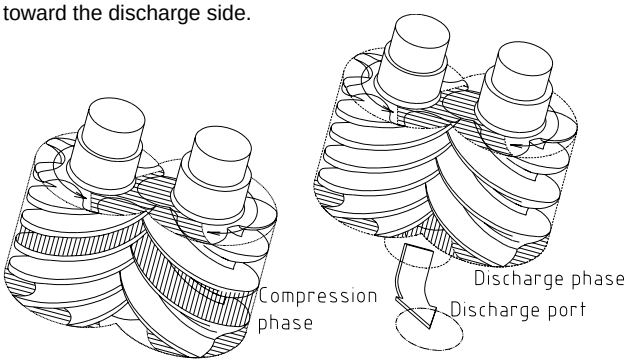
The rotors of different lobe shape mesh and the clearance between the M rotor lobe, F rotor groove and compressor casing increases gradually from the suction side as the rotors turn. When the clearance reaches the maximum as the rotors rotate further, this is sealed by the walls at both ends of the rotor and becomes independent.



Suction stage Suction side sealing

Compression Stage

As the rotors turn further, the volume between the lobes is decreased, compressing the trapped gas, while the sealing line moves toward the discharge side.



Compression stage Discharge stage

Discharge Stage

The volume between the lobes is decreased to the designated Vi, the clearance between the discharge port and rotors is linked and the gas is pushed out to the discharge side.

Lubrication Mechanism

There are two main forces that are occurring while the compressor is running. One force is caused by a combination of rotor weight and gas force. This is called “journal force”. The other force is an axial force that is caused by gas pressure difference between discharge gas and suction gas. It is called “thrust force”. Both forces vary per operating condition and volumetric ratio that user sets (see “Volumetric Ratio” in later page). To fight against these forces there are 5 different (6 for VR series) lubrications that are necessary for Mycom single stage screw compressors.

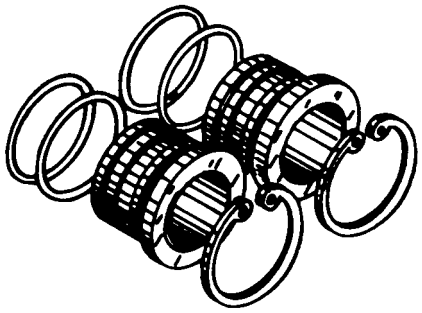
Type of lubrication

Type	Parts	Effects
Journal Lubrication	Radial Bearings (Side & Main)	Oil wedge Heat removal
	Thrust Bearings	Thrust force offset
Balance Piston	Balance Piston	Thrust force offset
Oil Injection	Rotors	Rotor seal Compression heat suppression
Mechanical Seal Lubrication	Mechanical Seal	Oil wedge Heat removal
Capacity Control	Slide valve	Hydraulic capacity control
Gear Lubrication	Integral Gear (VR series only)	Gear lubrication Heat removal

Radial Bearings (Side & Main)

The radial load of the compressor is absorbed by white metal-lined Hydrodynamic bearings. Rotor shaft floats in the pressurized oil in the bearing thus generates infinitive L10 life. The bearings are compliant to API619.

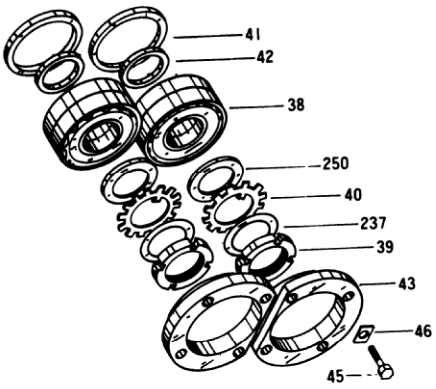
To achieve a longer life it is crucial to maintain the oil in good constant pressure, temperature and quality.



Radial Bearing

Thrust Bearings

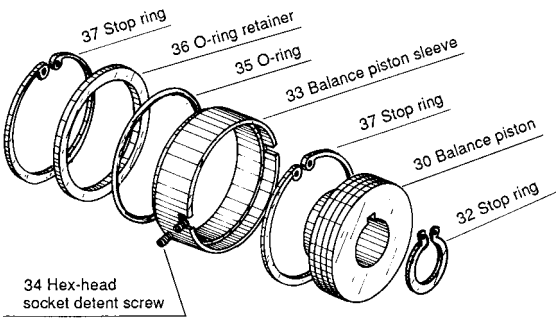
Axial thrust load on the rotor is absorbed by angular contact ball thrust bearings (Hydro-dynamic tilting pad thrust bearing for 400V). This is the only bearing that has L10 life (infinitive life for tilting pad thrust bearing). Each set of thrust bearings has two bearings, one for thrust force direction (from Discharge to Suction) and the other one for reverse direction (from Suction to Discharge).



Thrust Bearings

Balance Piston

Due to its rotor shape the male rotor usually receives higher thrust force than what female rotor receives. Thrust bearings on male rotors are sometimes not enough to take this high load. In order to help the male side thrust bearings a hydraulic piston is utilized to push the male rotor against the load. This is called Balance Piston.

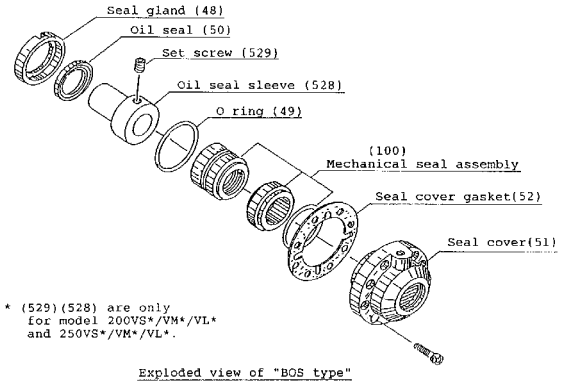


Balance Piston

Mechanical Shaft Seal

A new, single balanced type (double balanced type for 400V) mechanical shaft seal is used on the drive shaft. The mechanical seal utilizes O-ring packing to allow service with refrigerant gas.

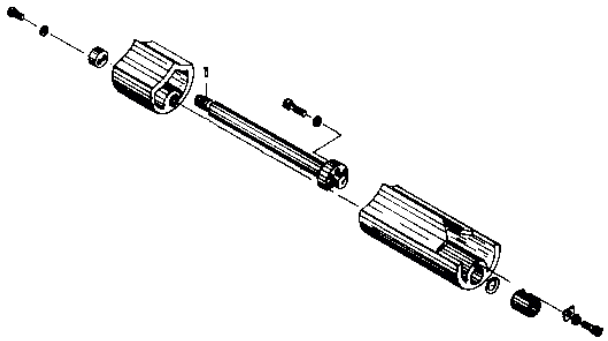
A combination of carbon and metals is chosen to assure the durability of the frictional parts and sealing effect.



Mechanical Shaft Seal

Uuloader Slide Valve

A hydraulically actuated slide valve is utilized for infinitive capacity modulation. The slide valve can be moved by pressurized lubrication oil to a cylinder and the oil pushes a piston that is connected to the slide valve. A cylinder indicator cam is provided to indicate position of the slide valve at each volumetric ratio that user sets per operating condition.

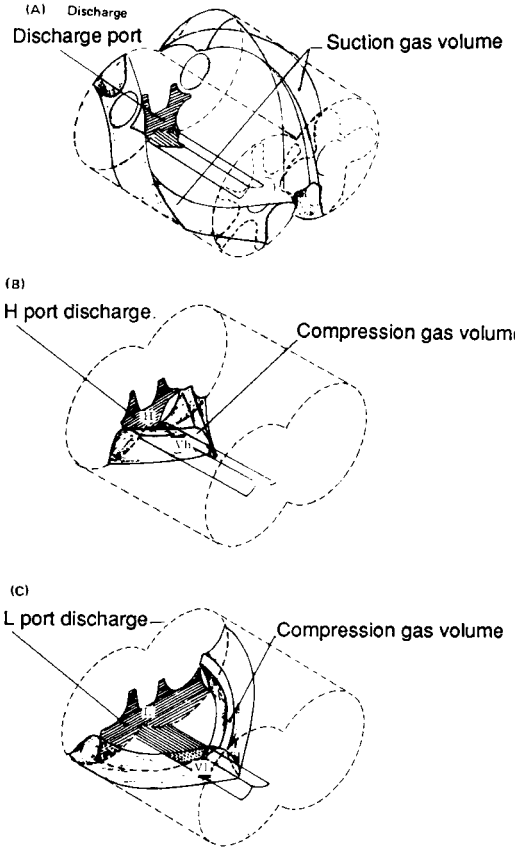


Unloader Slide Valve w/ Slide Stop valve

Volume Ratio

Suction gas is sucked into the groove between the rotors and this volume decreases while pressure increases as the rotors rotate. When the volume is decreased to the set Vi Ratio, the groove is linked to the discharge port and the compressed gas is pushed out.

The groove is linked to the discharge port according to the volume of the groove and is not dependent on internal pressure.



Internal Volume Ratio

Vi (Volumetric ratio) is used to present the value of the decreased volume of suction gas when the groove aligns with the discharge port (or is discharged).

This can be expressed as follow:

$$Vi = \frac{\text{Volume of suction gas when compression begins}}{\text{Volume of same quantity of gas at discharge port}}$$

It is assumed that the compression process of a screw compressor is an adiabatic (no heat is exchanged during the process) change, the optimum value of the built-in volume ratio can be calculated from the following formula.

$$Vi = \left(\frac{Pd}{Ps}\right)^{\frac{1}{k}}$$

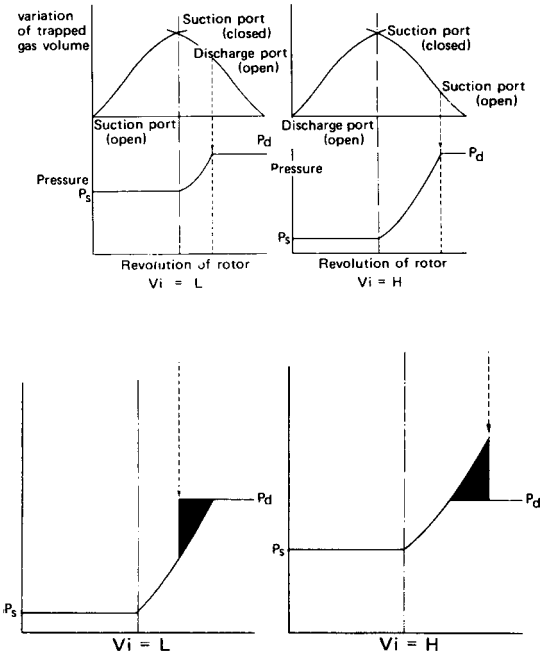
Vi : optimum built-in volume ratio

Pd : discharge pressure in absolute

Ps : suction pressure in absolute

K : specific heat

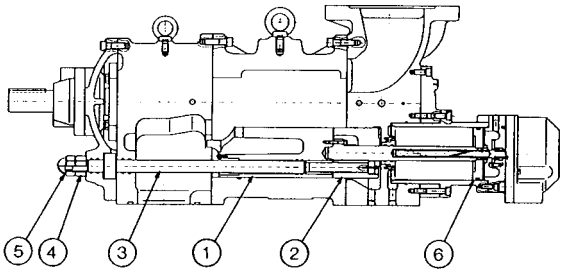
This volumetric ratio affects compressor efficiency at 100% capacity load. Over compression occurs when set Vi is higher than required Vi. Over compressed gas must be de-pressurized to meet the required discharge gas pressure. Lack of compression occurs when set Vi is lower than required Vi, in this case the compressor must provide extra compression in order to meet the required discharge gas pressure. These factors lead to excessive power consumption to achieve the goal compression.



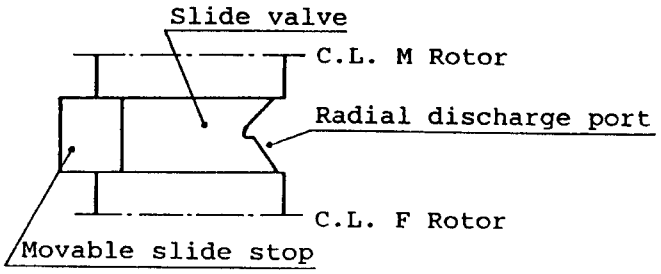
Relationship between design and operating conditions.

Slide Stop

All V and VR series compressors have a manually adjustable slide stop mechanism, and the slide vale/stop can be moved to the required position, therefore built-in volume ratio can be adjusted externally without opening the compressor.



(1) slide valve (for capacity control)
(2) movable slide stop (for Vi adjusting)
(3) adjustable Vi rod (4) hexagon nut (5) cap nut
(6) unloader piston



When the slide valve (1) is moved toward the discharge end, left direction, using the unloader piston (6), a slit between the slide valve (1) and slide stop (2) appears, and then a part of the compression gas is bled through this recirculation slit to the inlet chamber; part load condition.

The movable slide stop (2) makes it possible for the slide valve (1) and slide stop (2) to be moved together without creating a recirculation slit, i.e. the discharge port size and built-in volume ratio can be changed.

The variable Vi rod (3) has a male thread and the movable slide stop (2) has a female thread, therefore, the movable slide stop (2) can be moved by rotating the variable Vi rod (3) externally.

SINGLE STAGE SCREW COMPRESSOR PACKAGE DESCRIPTION

MYCOM has developed the ultimate compressor package **MYCRO-COLD "V" Series**. Designed & manufactured by MYCOM, the "V" series has many superb features, which work together to obtain maximum performance, easy operation, and industry-standard reliability and state-of-the-art microprocessor control. All the MYCOM "V" series compressors are manufactured at the main plant in Japan which has been certified by **ISO 9001** quality assurance program as a proof of high quality standards.

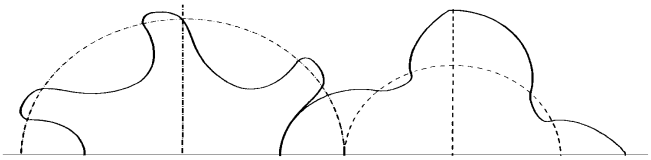
COMPRESSOR

Compressor Housing

Compressor housing is low porosity cast iron designed in compliance with ANSI/ASHRAE 15-1994. The compressor assembly is hydraulically tested at 350 psig. Cast steel body is also available.

Helical Screw Rotors

MYCOM **"O" Profile** is used in "V" series screw compressors. Higher efficiency is achieved by reducing the inter-lobe blow-by gas down to 60 % and by facilitating a build up of oil film on the rotor lobe surface by circular arc rotor profile rather than conventional raised sealing edge.



"O" ROTOR PROFILE

Journal Bearings

Main and side bearings are heavy-duty steel backed babbited type. The bearings are arranged for forced feed lubrication as standard. Proper oil management design assures longer bearing life without periodical replacement, which is mandatory for roller (anti-friction) type bearings.

Thrust Bearings

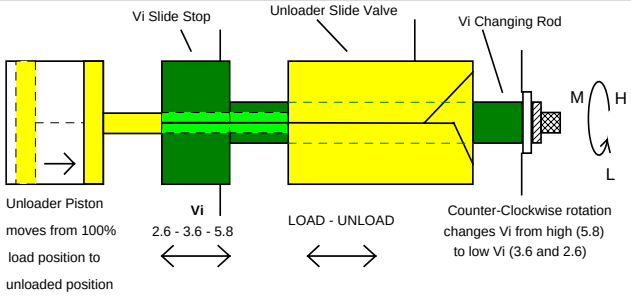
are angular contact ball bearings and receive axial loads on the male and female rotors. An enlarged balance piston is employed on the discharge side of male rotor to balance uneven loads on the rotors.

Shaft Seal

A **B**alanced, **O**-ring and **S**ingle (**BOS**) shaft seal is used. The shaft seal balanced structure enables more reliable performance. Special carbon graphite material is adapted to the BOS shaft seal, which gives much longer life at heavy duty operating conditions. High-speed oil seal is located on the bearing head side.

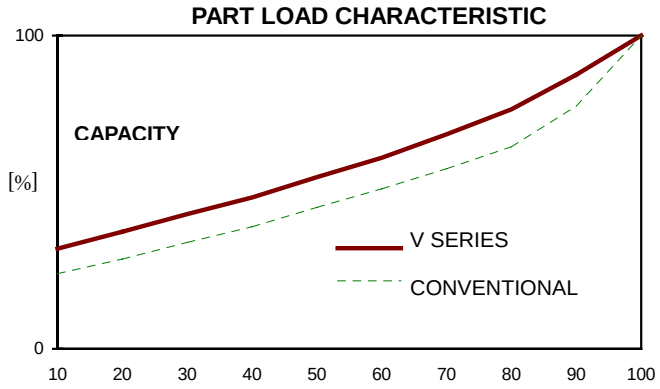
Variable Vi

"V" series compressors freely change the Vi (Internal volume ratio) whenever required, at the applicable range between 2.6 to 5.8 (2.2 to 5.0 as option), according to design operating condition prior to shipment from MYCOM. Manually adjustable variable Vi is standard. A fully automatic variable Vi control is available in "Vi" series screw compressor package.



CAPACITY CONTROL

The hydraulically operated slide valve regulates compressor capacity from 10% to full capacity. Part load efficiency is improved for V series compressors.



UNLOADER INDICATOR [%]

COMPRESSOR DRIVER

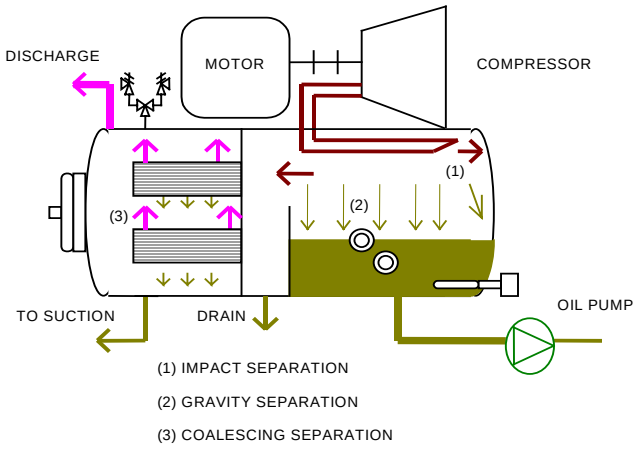
The screw compressor is driven by a directly coupled 2-pole electric motor running at 3550rpm (60Hz) or 2950rpm (50Hz). A flexible coupling, with a spacer for an easy replacement of shaft seal and an OSHA coupling guard, is supplied. Standard rotation is counter-clockwise looking at compressor shaft.

LUBRICATION SYSTEM

A complete system of compressor lubrication, oil separation, filtration, cooling and recirculation is designed carefully to maintain proper oil management using MYCOM's long and versatile experiences throughout the world.

Oil Separator

A high efficiency horizontal oil separator incorporates three-stage separation including fine coalescing elements. The oil separated by the fine coalescer elements is returned to compressor suction. Oil temperature in the large reservoir section is controlled by oil heaters used to maintain proper temperature during the shutdown. The separator is designed, constructed and certified by **ASME** Sect. VIII for 300psig operating pressure and is furnished with dual safety relief valves per ANSI/ASHRAE 15-1994. A vertical oil separator is also available depending on application.



Oil Pump

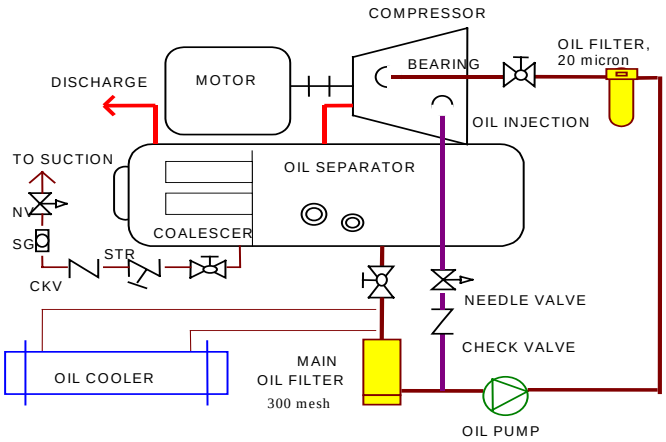
The MYCOM MP Series oil pump has a unique “double helical screw” design for partial and full flow oil systems. Cast steel body is available for MP pumps. The oil pump is directly driven by an electric motor to assure forced lubrication to the compressor bearings, shaft seal and balance piston. Injection oil is fed by pressure differential. Pre-lubrication at start up and re-positioning the slide valve to 0% at shut down are incorporated in microprocessor control.

Main Oil Filter

Oil is filtered through a 300 mesh filter located upstream of the oil pump. The filter element is a reusable and washable stainless steel mesh screen. A fine paper filter element is furnished at shipment from factory for oil flushing purposes during start-up, which is to be replaced by the reusable filter element after the start-up procedures.

Compressor Oil Filter

An additional oil filter with fine replaceable 20 micron element is provided at the compressor bearing oil inlet for added protection.



OIL COOLING

Thermosyphon Oil cooler - TSOC

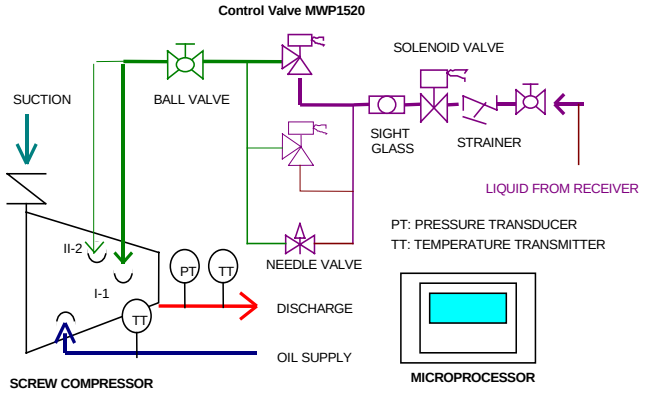
TSOC are mounted and piped for TS compressor packages. Liquid refrigerant at condenser pressure is circulated by gravity into the tube side providing cooling of oil passing through the shell side. TSOC is constructed to ASME Sect.VIII at design operating pressure of 400 psig. A 3-way oil temperature control valve (option) should be used when condensing temperature may become below 65°F. Oil temperature control valve is mounted and piped with isolation valves for servicing.

Water Cooled Oil Cooler - WCOC

WCOC are mounted and piped for water-cooled packages. Tubes are made of copper or carbon steel and shells are made of carbon steel at designed working pressure of 400 psig. PHE oil coolers may be selected for halocarbon applications. Oil temperature can be controlled by a thermal water-flow regulating valve (option) or by a 3-way oil temperature control valve (option) to maintain constant oil temperature.

"YOSAKU" Liquid Injection Oil Cooling - LIOC

MYCOM has developed an electronic pulse type liquid injection valve "YOSAKU". The microprocessor control panel continuously monitors discharge gas/oil temperature. The discharge gas superheat is precisely controlled. The degree of superheat is adjustable by users for different operating conditions such as booster and high stage. YOSAKU LIOC is the state-of-the-art screw compressor oil cooling system that maintains ideal super heat under any operating condition or with different refrigerants. As a result of stability and accuracy, power penalty and the risk of oil foaming or carry-over can be minimized. All “V” series screw compressors are provided with (2) liquid injection ports corresponding to operating Vi positions, low Vi port I-1 (2.6) or higher Vi port I-2 over 3.6.



OTHER COMPONENTS & SERVICES

Suction Strainer

A stainless steel 100 mesh, reusable suction strainer is mounted at the suction side of the compressor to prevent any particles from entering the compressor.

Check Valves

Suction and Discharge Check valves are factory-mounted on the package.

Discharge and Suction Stop Valve

Angle stop valve with a separate check valve is factory mounted at the discharge outlet of oil separator. An angle type suction stop valve is shipped loose for field installation.

Pump Down By-pass - Optional

Pump down piping with shut-off valve is mounted to evacuate refrigerant from package to the system for maintenance.

Oil Charge Valve and Strainer
A stop valve and strainer are mounted and piped for oil charge service at the suction side of the compressor.

Oil Sight Glasses
Three Bull's Eye oil sight glasses are installed on the oil separator . Two is for oil level. One is for suction oil return.

Drive Motor and Starter Package
Compressor drive motors are factory mounted and pre-aligned for easy start-up. Starter packages are shipped loose as an option. Customer-supplied motor will be charged for mounting.

Initial Oil Charge
MYCRO-COLD AB-68 premium quality synthetic compressor lubricant is shipped separately or pre-charged with the package for Initial oil charge within Continental USA.

Other lubricants can not be substituted without Mycom's authorization.

Economizer (Liquid Subcooler) Heat Exchanger
The factory mounted and piped liquid subcooler provides subcooling of refrigerant liquid between condenser and evaporator. The economizer is effective for single stage systems at medium and low temperature applications. A DX S&T heat exchanger is standard. A DX PHE type may be used for halocarbon applications. A valve kit may be supplied to provide a connection to external systems such as intercoolers or constant pressure receivers.

Paint Color
Standard paint color is Gray Munsel-N7. MYCOM will also accept customer specified color options.

Start-Up Supervision
MYCOM factory technicians provide start-up supervision in North America. Maximum two days per unit is standard at a fixed contract price. Overseas and extended hour start-up services are optional.

OPTIONAL SPECIFICATIONS

Automatic Variable Vi Control
Select the variable Vi screw compressor and control system among the MYCRO-COLD "Vi" Series Packages. See details in "Vi" series specification.

Dual Oil Filter
An additional oil filter with isolation valves mounted and piped permits changing the oil filter element without interrupting compressor operation. Select from compressor inlet or oil pump inlet side (or both).

Dual Oil Pump
An additional stand-by oil pump mounted and piped on the package. Automatic start control can be supplied as option.

Full Flow Oil Pump
A larger size oil pump mounted and piped for pumping the full flow both oil injection and lubrication oil to the compressor. Booster packages require the full flow pump.

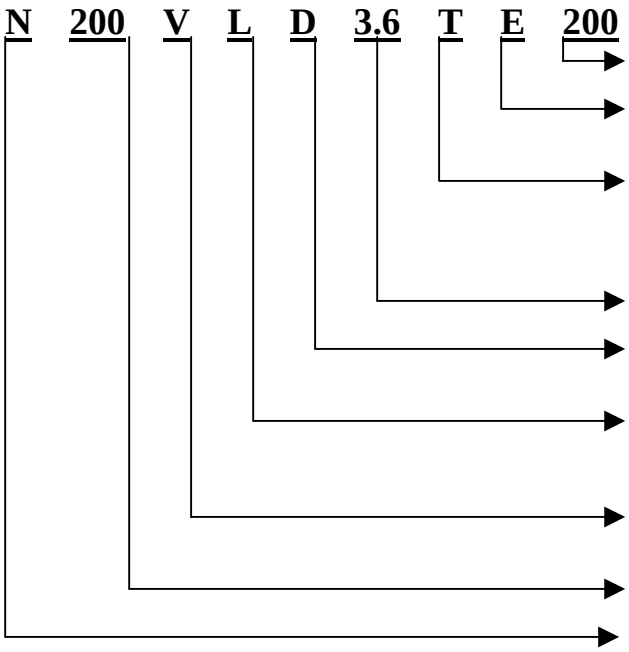
Compressor Specification
Optional specifications are available such as:
- Explosion-Proof Capacity Indicator
- Thrust Bearing Sensor
- Tilting Pad Thrust Bearing
- Cast Steel Casing
- Forged Steel Rotor
- Viton O-rings
- Double Mechanical Seal

"C" Type Compound Compressor
The MYCOM internally compounded screw compressor is available as MYCRO-COLD "C" series, compact and high performance for low temperature applications. See details for "C" series specification.

Design-Build Package
MYCOM can engineer and fabricate design-build packages for refrigeration, process cooling and co-generation including chillers, heat exchangers, pressure vessels and Diesel or Gas engine drivers.

Complete Customized System Control
- Auto-staging of multiple compressors
- Networking with other MYPRO controls
- Remote monitoring and control via modem
- On-site monitoring by a remote PC
- Communication with third party components

SINGLE STAGE SCREW COMPRESSOR PACKAGE MODEL DESIGNATION



DRIVE MOTOR HP

ECONOMIZER OPTION:
- [E] economizer (DX or PHE)
- [none] no economizer

OIL COOLER:
- [T] thermosyphon
- [W] water-cooled
- [I] liquid injection
- [D] DX

Vi SELECTION: [2.6,3.6,5.8] pre-set for required application

COMPRESSOR CONFIGURATION:
- [D] horizontal discharge outlet
- [G] vertical discharge outlet

COMPRESSOR ROTOR LENGTH:
- [S] short rotor length
- [M] medium rotor length
- [L] long rotor length

COMPRESSOR MODEL:
- [V] series
- [VR] series

COMPRESSOR SIZE: [ROTOR DIAMETER] in mm

REFRIGERANT:
- [N] ammonia / R717
- [F] freon / R22

SINGLE STAGE SCREW COMPRESSOR MODELS

Model		Vi		Cap Control	CFM	Model		Vi	Cap Control
		Adjustable	Fixed	Infinitive *	at 3550rpm			Fixed	Step **
STANDARD SINGLE STAGE SCREWS						**MINI SCREWS (See I-Series Information)**			
					59	FM10	S	O	None
					103	FM11	S	O	None
125	SUD		O	O	140	i125	S	O	50/75/100%
	LUD		O	O	208		L	O	50/75/100%
160	VSDS	O		O	262	i160			
	VDS	O		O	294		S	O	50/75/100%
	VMDS	O		O	327				
	VMD	O		O	367		M	O	50/75/100%
	VLDS	O		O	392				
	VLD	O		O	441		L	O	50/75/100%
200	VSDS	O		O	511				
	VDS	O		O	574				
	VMDS	O		O	639				
	VMD	O		O	718				
	VLDS	O		O	765				
	VLD	O		O	859				
250	VSDS	O		O	995				
	VDS	O		O	1118				
	VMDS	O		O	1247				
	VMD	O		O	1401				
	VLDS	O		O	1487				
	VLD	O		O	1671				
320	VSDS	O		O	2003				
	VDS	O		O	2250				
	VMDS	O		O	2492				
	VMD	O		O	2800				
	VLDS	O		O	2982				
	VLD	O		O	3350				
	LLUD		O	O	3970				
400	VSD	O		O	4590				
	VMD	O		O	5760				
	VLD	O		O	6891				
	LLUD ***		O	O	8120				

* Infinitive control by slide valve (10 ~ 100%)

** Step control by unloader piston

*** For booster application only. Consult with Mycom

PACKAGE DIMENSIONS – FOR REFERENCE USE ONLY

SINGLE & HIGH STAGE

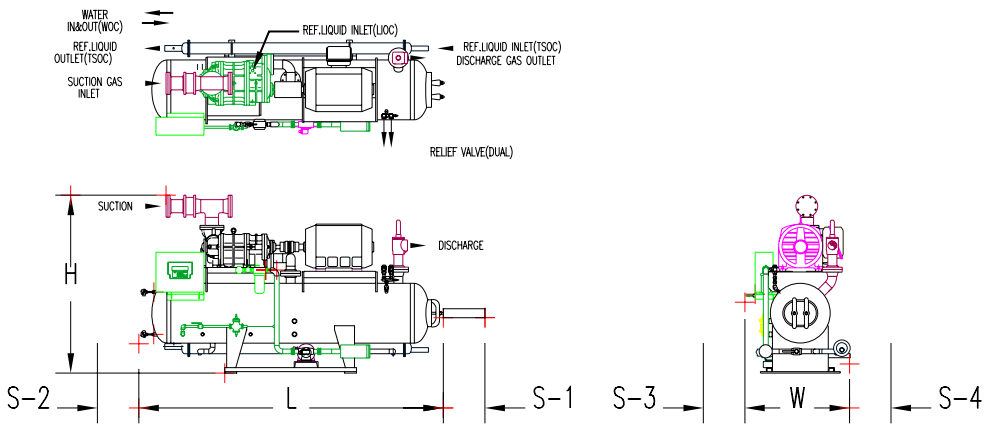
MODEL	MAXIMUM MOTOR FRAME	APPROXIMATE DIMENSION (INCH)								APPROX SHIPPING WEIGHT (LB) (LESS MOTOR)		
		Liquid Injection		Thermosyphon		Water Cooled		Height	Clearance			
		W	L	W	L	W	L	H	S-1	LIOC	TSOC	WCOC
125SUD	405TS	40	106	51	106	52	106	68	20	2600	3000	3000
125LUD	405TS	40	110	50	110	52	110	68	20	2700	3050	3050
160VSD	405TS	40	110	48	110	50	110	71	20	3050	3400	3400
160VMD	405TS	44	128	53	128	53	128	76	20	4250	4300	4300
160VLD	444TS	44	130	53	130	52	130	76	20	4300	4800	4800
200VSD	445TS	44	136	53	138	53	138	81	20	5000	5450	5450
200VMD	445TS	50	152	59	152	61	152	90	40	6300	6850	6850
200VLD	505USS	50	154	59	154	62	154	94	40	6400	6950	6950
250VSD	505USS	50	156	68	156	64	156	95	40	7650	8600	8600
250VMD	507USS	60	188	80	188	81	188	106	40	10,600	11,750	11,750
250VLD	507USS	60	191	80	191	81	191	106	40	10,800	11,950	11,950
320VSD	355-1220	60	195	80	195	81	195	113	40	13,350	14,850	14,850

FOR 320VMD, 320VLD, 320LLUD, 400VSD, 400VMD, 400VLD COMPRESSORS, PLEASE CONSULT MYCOM OFFICE

FOR CONDITIONS: Refrigerant: Ammonia Condensing Temperature: +95°F
Evaporating Temperature:+20°F Oil Supply Temperature:120°F Speed: 3550 RPM

WATER COOLED OIL COOLER: Shell & Tube 2-pass oil cooler is standard for ammonia.
Plate type heat exchanger may be used for R22.

LIOC: Liquid Injection Oil Cooler TSOC: Thermosyphon Oil Cooler WCOC: Water Cooled Oil Cooler



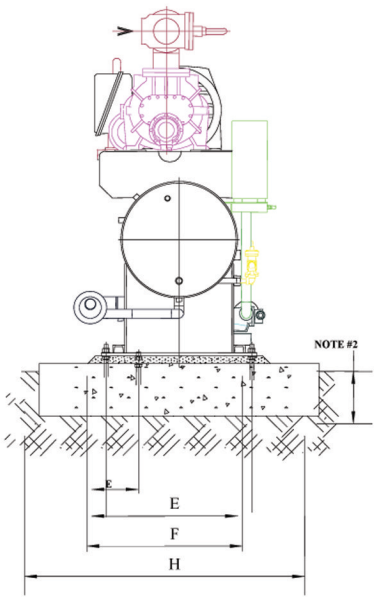
S-1: Service clearance for coalescer filter cartridge replacement

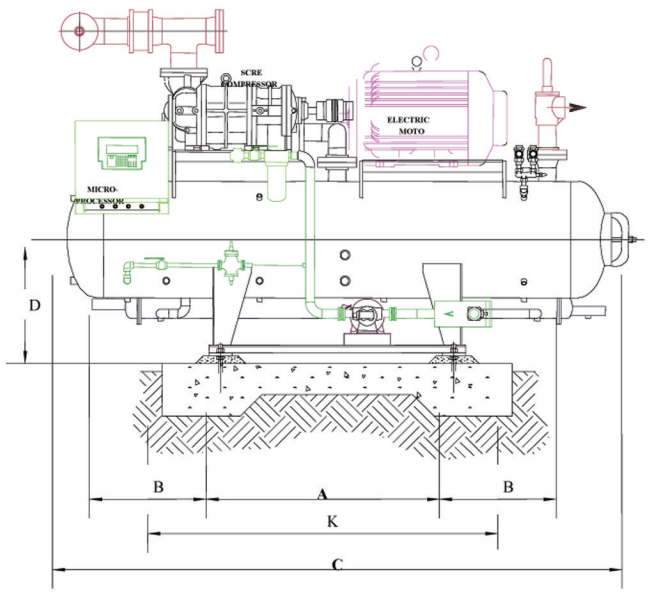
S-2: [12”] Maintenance space for temperature sensor bulbs

S-3: [24”] Service clearance for microprocessor panel door (fully open) and oil pump maintenance

S-4: [12”] Service clearance for liquid injection valve, economizer, thermosyphon safety valve

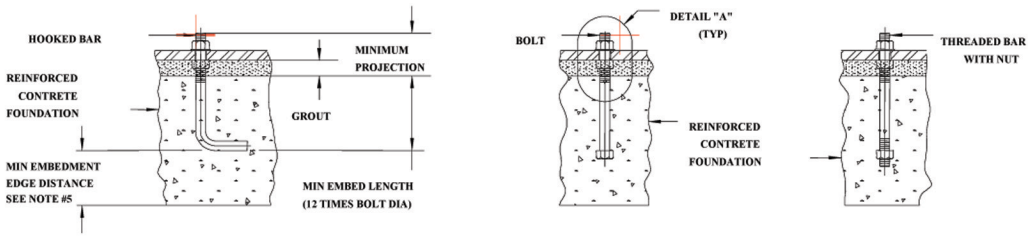
PHYSICAL DATA – FOR REFERECNE USE ONLY



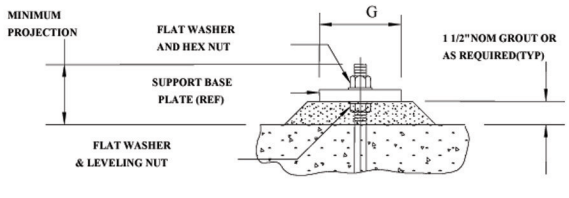


GENERAL NOTES:

1. DO NOT SCALE DRAWING.
   ALL DIMENSIONS SHOWN ARE APPROXIMATE.
2. CONCRETE SLAB/FOUNDATION THICKNESSES AND REINFORCEMENT TO BE DETERMINED BY CUSTOMER. DESIGN AND CONSTRUCTION OF FOUNDATION TO BE IN COMPLIANCE WITH LOCAL CODES.
3. EXPANSION TYPE EPOXY GROUT SHOULD BE USED. THE GROUT MUST BE WORKED UNDER THE BASE PLATE SO THAT THERE ARE NO VOIDS OR NON-BEARING AREAS.
4. ANCHOR BOLT MATERIAL TO BE A307 BOLTS OR A36 THREADED BAR. ANCHOR BOLTS COULD BE EITHER CAST-IN-PLACE OR DRILLED IN PLACE. FOR DRILLED-IN PLACE ANCHOR BOLTS, EMBEDMENT AND INSTALLATION SHALL BE PER ANCHOR BOLT'S MANUFACTURER SPECIFICATIONS.
5. ANCHOR BOLTS EMBEDED EDGE DISTANCE SHALL NOT BE LESS THAN 5 TIMES THE ANCHOR BOLT NOMINAL DIAMETER OR 4 INCHES, WHICHEVER IS GREATER.



CAST - IN - PLACE ANCHORS



DETAIL "A"

JN/94

MODEL NUMBER	DIMENSIONS (INCHES)					BASE PLATE		FOUNDATION		ANCHOR BOLTS				AXIAL LOAD PER SUPPORT
	A	B	C	D	E	F	G	H	K	QTY/SPT	SIZE	PROJ	SHEAR/BOLT	
OS2072	47	12 1/2	99	25	27.5	30	5	48	72	2	3/4	4	150#	2500#
OS2496	50	23	138	27	34.0	37	6	54	80	6	3/4	4	250#	4000#
OS301203	60	30	156	30	37.5	40	6	66	90	3	1	4 1/2	250#	6000#
OS361444	90	27	195	35	42.0	46	7	78	120	3	1 1/4	5	350#	8000#
OS421685	102	33	197	36	50.0	54	8	84	132	4	1 1/4	5	400#	12000#
OS481686	102	33	200	39	55.0	59	10	96	138	5	1 1/4	5	400#	15000#

MYCOM N. A.

TITLE: MICRO COLD "V" SERIES
FOUNDATION LOADING
DETAILS

SIZE	DWG.NO.	REV.
B	STDFDN	0

OS20..: 125-160VSD OS24..: 160VMD/VLD-200VSD OS30..: 200VMD/VLD-250VSD OS36..: 250VMD/VLD-320SUD OS42..: 320MUD/LUD
(These selections are applied to standard conditions R-717 single stage 3600rpm only. Oil Separator size is subject to change by design parameters)

MYCOM
THE EXPERTS IN INDUSTRIAL REFRIGERATION

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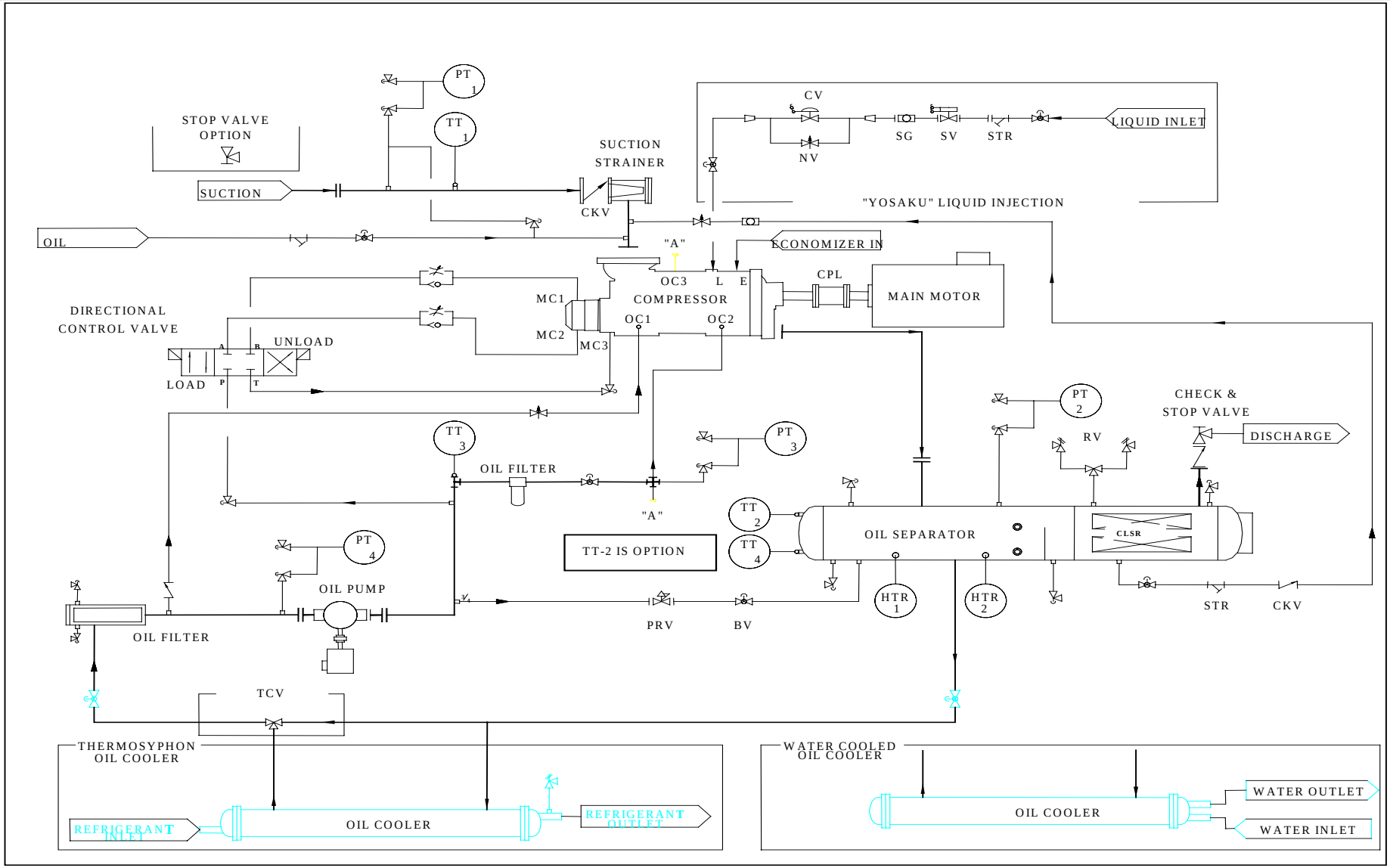
Bulletin: T-SU-G-001
Supersedes: New

P & ID DIAGRAM – FOR REFERECNE USE ONLY



LEGEND:										
	PT	PRESS TRANSDUCER	TT	TEMP SENSOR	RV	PRESS. REG. VALVE	CKV	CHECK VALVE	STR	STRAINER
	SG	SIGHT GLASS	HTR	HEATER (OIL)	CV	CONTROL VALVE	RV	RELIEF VALVE	NV	NEEDLE VALVE
	TCV	TEMP. CTRL VALVE	CLSR	COALESCER	NVC	NEEDLE VALVE W/ CK	CPL	COUPLING	MC1	UNLOAD
	OC1	OIL INJECTION INLET	MC3	DRAIN	OC2/3	BEARING LUBE INLET	MC2	LOAD	L	LIQUID INJECTION INLET
	E	ECONOMIZER INLET								

MYCOM
THE EXPERTS IN INDUSTRIAL REFRIGERATION

For Reference Use Only, Supersedes All Previous Issues. Subject To Change Without Notice.

PACKAGE DATA – FOR REFERENCE USE ONLY

DESIGN CONDITIONS: • Refrigerant: Ammonia • Condensing Temperature: 95°F • Evaporating Temperature +20°F • Oil Supply Temperature: 130°F • Speed: 3550RPM

MODEL	CONNECTION		TSOC			WCOC			LIOC		RELIEF VALVE	OIL PUMP MOTOR		INITIAL OIL CHARGE (GALLON)	
	SUCT (R22)	DIS CH.	CONNECTION		FLOW	CONNECTION	FLOW	PRESS DROP	CONNECTION	FLOW					
			IN	OUT	LB/H	IN / OUT	GPM	PSI	INLET	LB/H	OUT	HP	RPM	LIOC	EXT
125SUD	4	2	2	2 ½	643	1 ½	16	3	¾	219	1	3	1800	33	35
125LUD	4	2	2	2 ½	868	1 ½	21	3	¾	324	1	3	1800	33	35
160VSD	4	2 ½	2	2 ½	1190	1 ½	29	4	¾	447	1	3	1800	33	35
160VMD	4	2 ½	2	2 ½	1431	1 ½	35	3	¾	550	1	3	1800	70	74
160VLD	4	3	2	2 ½	1593	2	39	4	¾	664	1	3	1800	70	74
200VSD	5 (6)	3	2 ½	3	2219	2	54	5	¾	781	1	3	1800	70	74
200VMD	6	4	2 ½	3	2692	2 ½	65	5	¾	1072	1	3	1800	105	110
200VLD	6	4	2 ½	3	2980	2 ½	72	6	¾	1272	1	3	1800	105	110
250VSD	6 (8)	4	3	4	4025	2 ½	97	7	¾	1639	1	3	1800	105	110
250VMD	8	5	4	5	4949	3	120	5	¾	2039	1 ½	5	1200	200	212
250VLD	8	5	4	5	5467	3	132	6	¾	2468	1 ½	5	1200	200	212
320VSD	8 (10)	5	4	5	8394	5	203	7	1	3266	1 ½	7 ½	1200	200	212
320VMD	10 (10)	6	5	6	10228	5	247	7	1	4146	1 ½	7 ½	1200	275	302
320VLD	10 (10)	6	5	6	11365	5	274	7	1	4958	1 ½	7 ½	1200	375	385

STANDARD ITEMS INCLUDED:

- Rotary Screw Compressor, New “O” Rotor Profile
  - ❶ “V” Series – Manually Adjustable Vi (160-200-250)
  - ❷ “Vi” Series - Automatic Vi (160-200-250-320)
  - ❸ “UD” Series - Fixed Vi
- Horizontal Coalescing Oil Separator

  3-Stage Separation, ASME Sect.VIII 300 psig
- Suction Gas Strainer
- Suction Check Valve
- Suction Stop Valve (Shipped Loose)
- Discharge Stop-And-Check Valve (Or Check Valve & Angle Stop Valve)
- Safety Relief Valve (Dual)
- Drive Motor
- Motor Coupling With Spacer
- Coupling Guard (OSHA)
- Oil Pump (1)
- Oil Pump Motor
- Oil Pump Coupling
- Main Oil Filter 10 micron (1)
- Oil Filter, Compressor Lubrication (1)
- Spare Oil Filter Cartriges (1 each)
- Oil Level Sight Glass (2)
- Microprocessor Control Panel Mypro-M

  Type M-K-11 (A/D CH:16/16) Single Stage

  Type M-K-21 (A/D CH:16/32) 2-stage, remote, Vi
- Oil Cooler:
  - ❶ Liquid Injection, “YOSAKU” microprocessor Controlled Pulse Control Valve
  - ❷ Thermosyphon/Water Cooled Oil Cooler, External Shell & Tube Type 1-Pass (Dual Purpose)
  - ❸ Water Cooled Oil Cooler, External Shell & Tube 2-Pass (NH3-R22) or Plate Heat Exchanger (R-22)
- Initial Oil Charge, Mycold AB-68 Synthetic Oil

OPTIONAL ITEMS:

- Motor Starter
  - ❶ Across-The-Line (ATL)
  - ❷ WYE Delta - Closed Transition
  - ❸ Autotransformer (125A & 320)
  - ❹ Solid State (Soft Starting)
- Economizer Option
  - ❶ DX Shell & Tube or Plate Heat Exchanger mounted with controls
  - ❷ Hardware Kit only (Strainer + Check Valve)
- Dual Oil Filter
  - ❶ Main Filter, Oil Pump Suction
  - ❷ Compressor Bearing Filter, Oil Pump Down Stream
- Dual Oil Pump with Isolation Valves
- Microprocessor Control Options
  - ❶ Control Panel (A/D Channels)

    Mypro-M M-K-11 (16/16) Large LCD

    Mypro-M M-K-21 (16/32) Large LCD

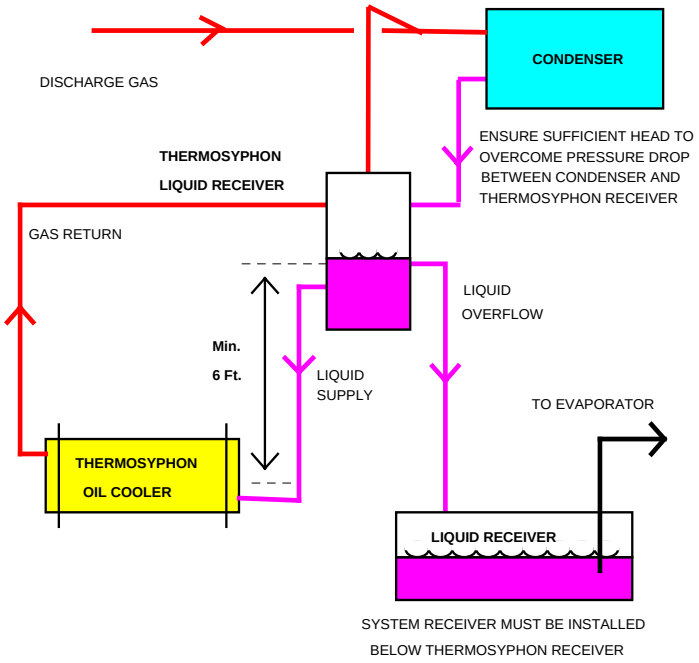
    Mypro-MCS MCS-A-11 (16/16) Large LCD+Box

    Mypro-MCS MCS-A-21 (16/32) Large LCD+Box

    Mypro-MCS MCS-A-22 (32/32) Large LCD+Box
  - ❷ Remote Capacity Control
  - ❸ Auto Staging Control
  - ❹ Condenser Fan Control (6 stages)
  - ❺ Modem Communication
  - ❻ Operator Console Communication
  - ❼ Network Communication
  - ❽ Third Party Protocol
- Vertical Oil Separator Skid
- MYCOM Oil Pump (Double Helical Screw Gear)

THERMOSYPHON OIL COOLER-TSOC:

TSOC can eliminate power and capacity penalties caused by liquid injection oil cooling and water or glycol pump motor power and frequent tube maintenance required for water cooled oil coolers. For gravity recirculation of refrigerant liquid through the oil cooler, a separate thermosyphon liquid receiver must be installed between the condenser and liquid receiver with minimum 6 feet of head between liquid level and oil cooler. The system liquid receiver must be installed below the thermosyphon receiver.



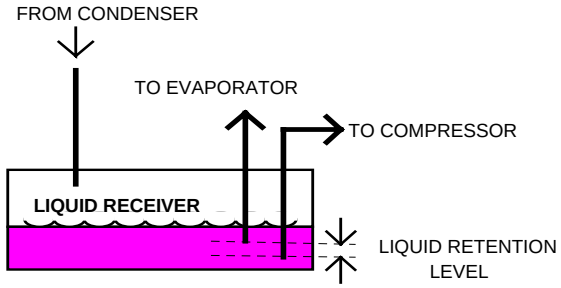
WATER COOLED OIL COOLER-WCOC:

An optional thermal water regulating valve sensing oil outlet temperature to control oil temperature at 110°F to 130°F is to be field installed.

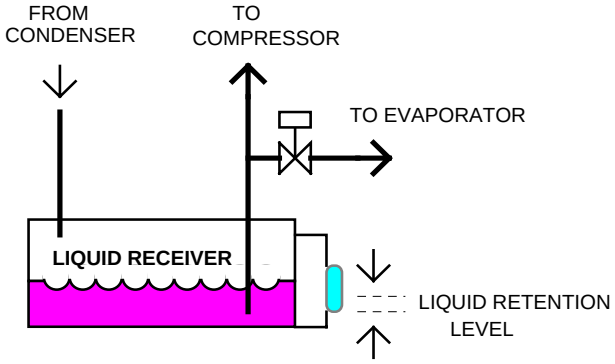
LIQUID INJECTION OIL COOLING-LIOC:

MYCOM uses YOSAKU microprocessor controlled pulse liquid injection valve. Screw compressors are provided with dual liquid injection inlet ports - Low Vi ratio below 3.6 (I-1) and high Vi 3.6 or higher (I-2). Liquid refrigerant for injection system must be supplied continuously without interruption. For these purposes, it is imperative that customer provides an oversized liquid receiver to retain minimum of **(5) minutes** of refrigerant liquid supply for screw compressor oil cooling. Required refrigerant mass (LB) can be calculated from the table in the previous page (Liquid Injection Flow rate LB/H divided by 12 for ammonia) and volume (FT^3) by (Mass LB divided by 37 for ammonia).

METHOD-1 uses (2) dip tubes in the receiver separately for evaporators and oil cooling. Oil cooling dip tube intake must be located lower than the dip tube for evaporators to assure uninterrupted liquid supply for oil cooling.



METHOD-2 uses (1) dip tube connecting to evaporators and compressor oil cooling. Oil cooling line has to be always kept open. The level switch closes liquid supply solenoid valves for evaporators when receiver liquid level becomes lower than 5 minutes supply of refrigerant for oil cooling.



YOSAKU LIQUID INJECTION OIL COOLER (1/3)

MYCOM's Liquid Injection Oil Cooling system employs "YOSAKU" Pulse Control Valve combined with Microprocessor Control. This oil cooling system works by cycling the YOSAKU control valve in an "OPEN" position for certain duration of time. This duration is the result of a calculated PID control output. The control input for the PID calculation is the degree of discharge gas superheat in a screw compressor package. This degree of superheat is calculated by actual discharge temperature minus saturated condensing temperature converted from discharge pressure based on Refrigerant Pressure-Temperature tables built into microprocessor. (SH = DT - SCT)

For Booster application, YOSAKU will control Oil (Discharge) Temperature instead of Super Heat. (PV = Oil Temperature

YOSAKU valve will be closed when discharge temperature falls below 104°F where oil cooling is not required.
PID output is represented by percentages. Every (10) % corresponds to (1) second pulse of solenoid valve action when "Integral time" is set to 10 sec. For example, when calculated PID output is 43%, YOSAKU valve "OPEN" duration will be (4) seconds (40%) and "CLOSED" period will be (6) seconds (60%).

YOSAKU Control System Advantages:

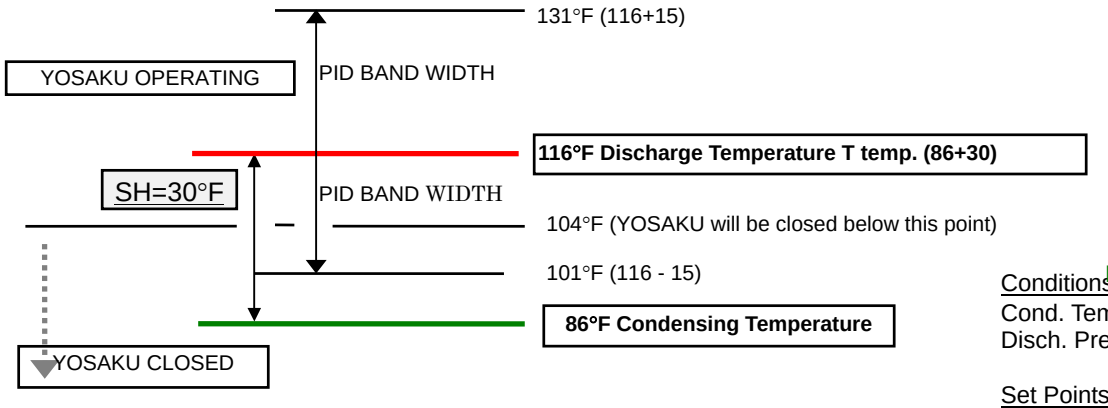
- Discharge & Oil temperatures are controlled by adding constant and precise superheat values above saturated condensing temperature
- Quick response to fluctuating load and floating discharge pressure by ON-OFF pulsating action
- Eliminates liquid flood-back and oil foaming that assures extended compressor service life
- Extremely wide capacity control range from 5% to 100% enables optimum valve size selection

PID Control Value Setting in the Microprocessor Control Panel

	SET
BOOSTER=NO	**PV=Super Heat**
SET POINT (SH)	**[30.0] .F**
P.BAND (%)	**[30.0]**
INTEGRAL TIME	**[10.0] Secs**
DERIVATIVE TIME	**[0.0] Secs**
MVH (%)	**[100.0]**
MVL (%)	**[0.0]**

Booster=Yes/No is to be preset by setup menu
"YES" is to control Oil Temperature (OT) for booster (PV=Process value)
"NO" to control Super Heat (SH) for single/high stage machines
Proportional bandwidth, narrower is more responsive to deviation value
Sets maximum duration of time for response. Set to 10 sec by default
Normally set to "0" to disable derivative time control
Maximum limit of high value PID output %. Set to 100% working range
Minimum limit of low value PID output %. Set to 0% working range

Analog Input values:
OT: Oil Supply Temperature
DT: Discharge Temperature
DP: Discharge Pressure To be converted to Saturated Condensing Temperature [TC]

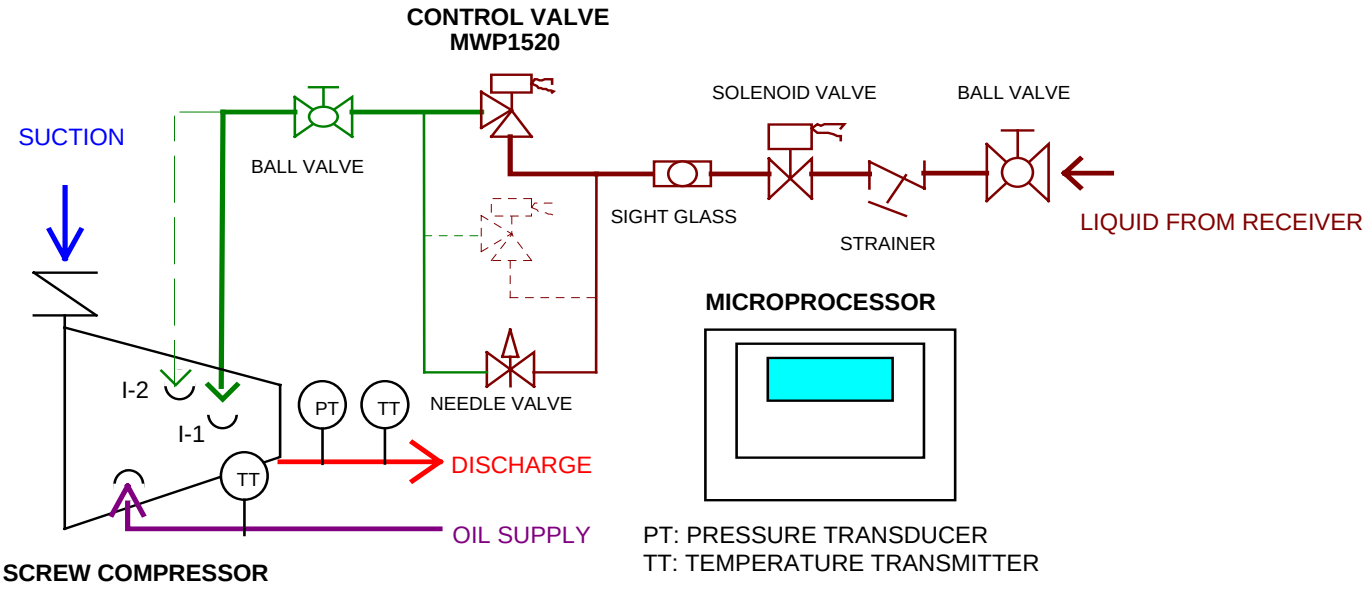


EXAMPLE

Conditions:
Cond. Temp.: 86°F
Disch. Press.: 155 psig

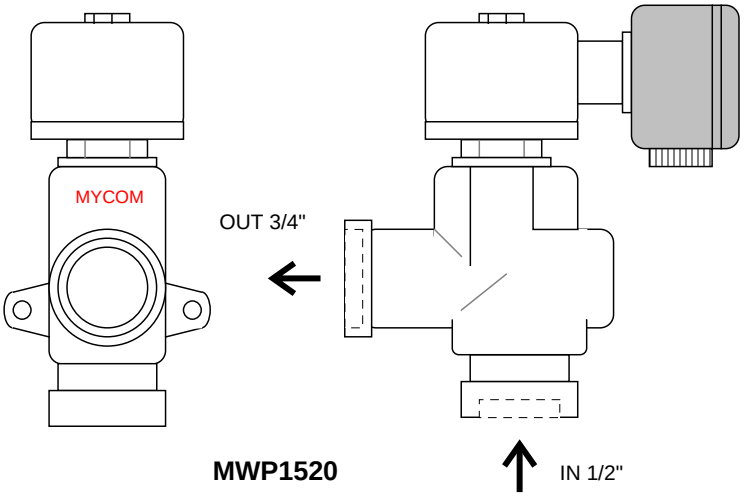
Set Points:
Booster=NO PV=Superheat/SH
Superheat: 30°F
Band Width: 30%
Integral time: 10 secs

YOSAKU LIQUID INJECTION OIL COOLER (2/3)



Liquid Injection Inlet Ports furnished on V series screw compressors:

I-1: For compressor Vi below 3.6
I-2: For compressor Vi 3.6 and higher



ORIFICE SIZE (VALVE QTY)

N125SUD	E (1)
N125LUD	E (1)
N160VSD	E (1)
N160VMD	E (1)
N160VLD	E (1)
N200VSD	G (1)
N200VMD	G (1)
N200VLD	G (1)
N250VSD	G (2)
N250VMD	G (2)
N250VLD	G (2)

ORIFICE	***Cv #***
A	1.04
B	0.08
BC	0.11
C	0.14
D	0.22
E	0.31
F	0.42

Cv VALUE FORMULA:

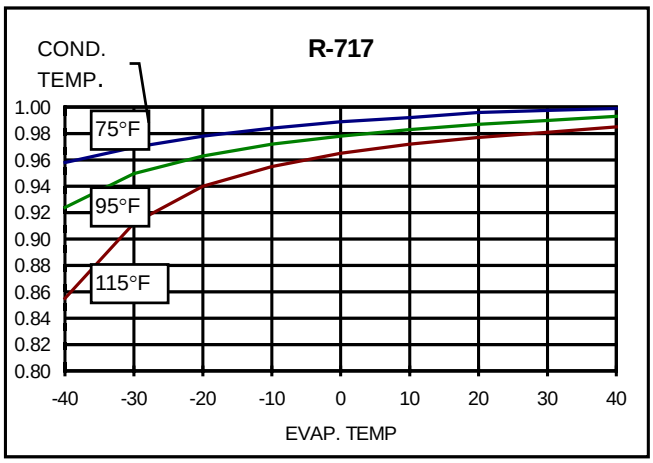
$$Cv = 0.53 \times \frac{GL(lb/hr)}{1198 \times r(lb/gal)} \times \sqrt{\frac{S}{0.0703 \times \Delta P}} \times k$$

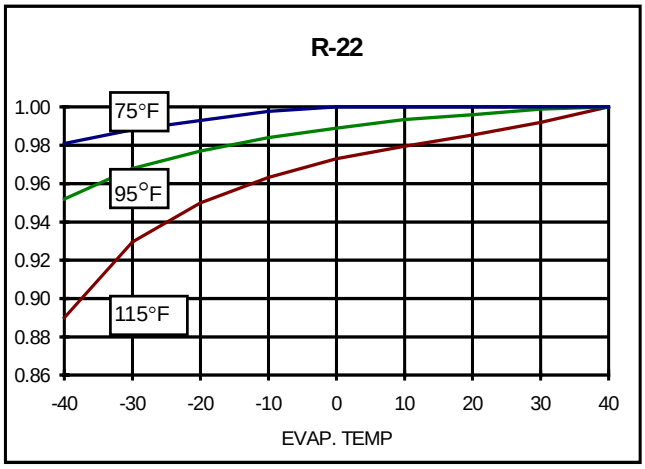
GL	Refrigerant flow rate lb/hr
r	Density (lb/gal) of liquid before TX valve
S	Specific Gravity of liquid before TX valve
ΔP	Pressure Differential across valve orifice
k	Correction Factor Ammonia=1.95 R-22=1.5

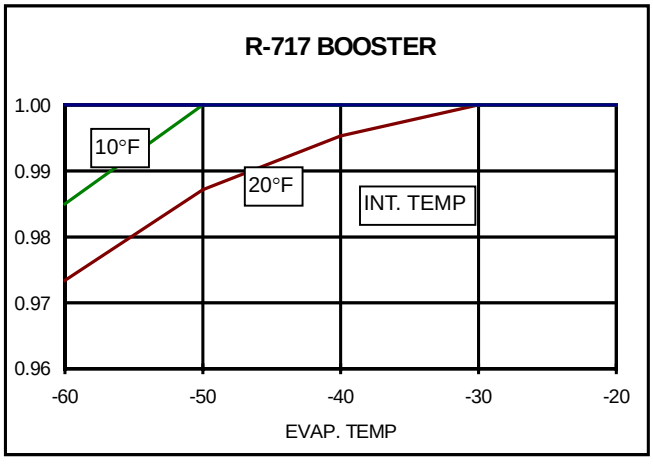
YOSAKU LIQUID INJECTION OIL COOLER (3/3)

CAPACITY/BRAKE HORSE POWER CORRECTION FACTOR

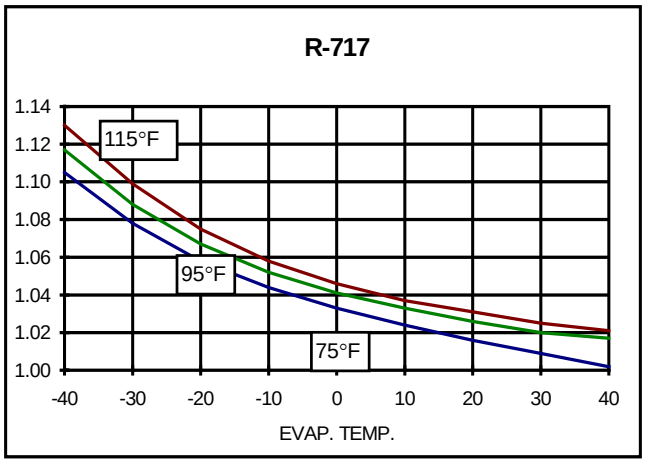
CAPACITY DECREASE (TR)

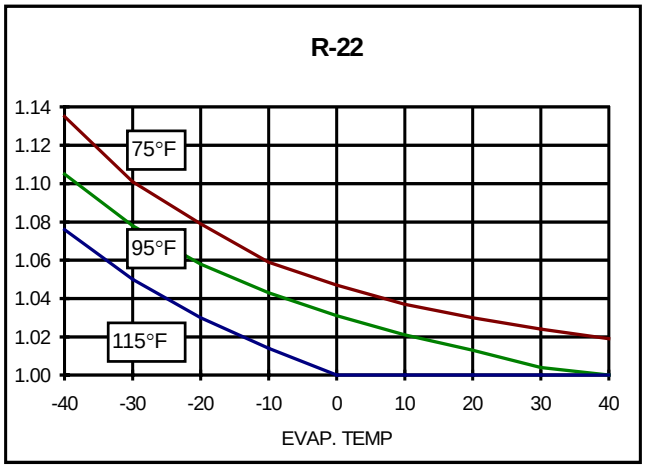


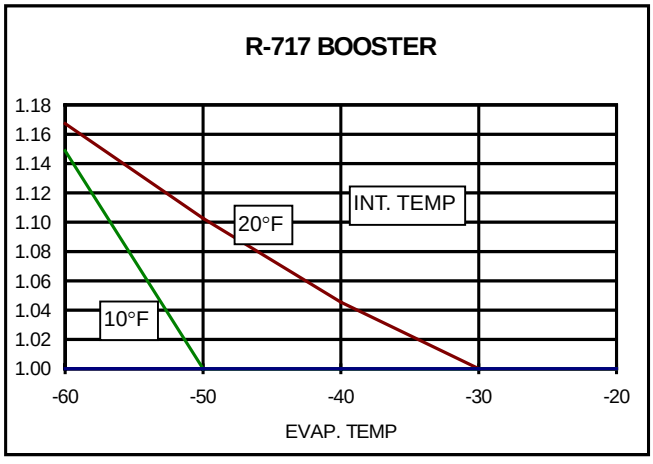




BRAKE HORSE POWER (HP)



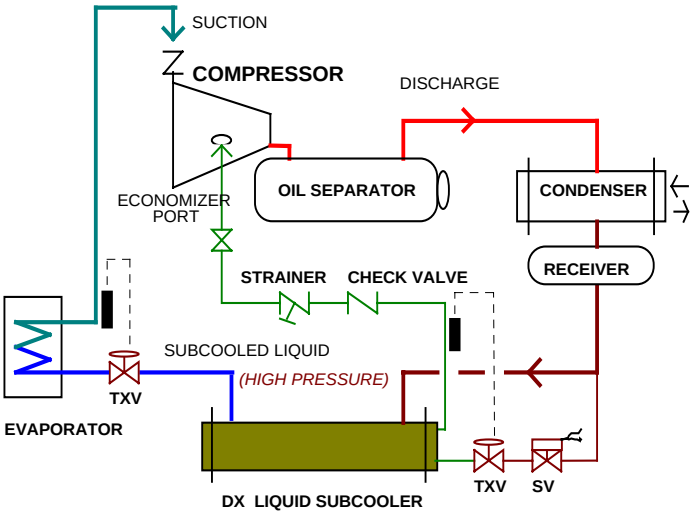




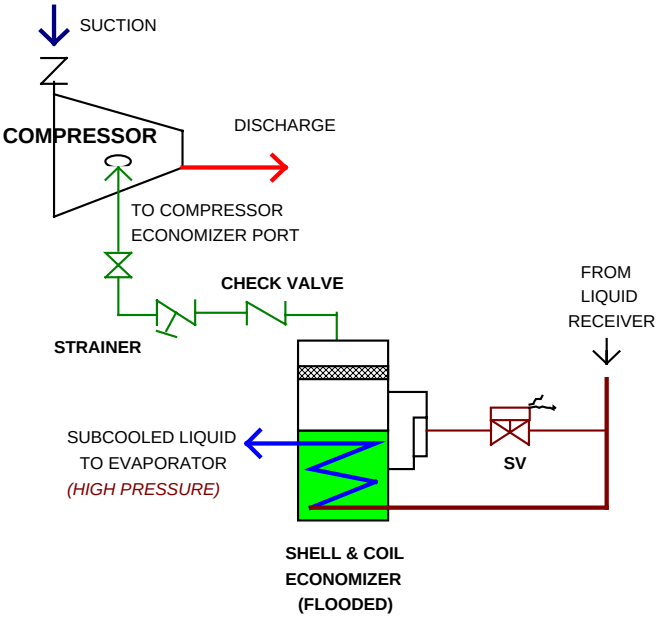
- "YOSAKU" PULSE INJECTION CONTROL VALVE (MICROPROCESSOR CONTROLLED)
- DISCHARGE TEMPERATURE: 140°F FOR AMMONIA AND 150°F FOR R-22

ECONOMIZER PIPING ARRANGEMENTS

The Screw Compressor Economizer increases system capacity and efficiency by subcooling high-pressure liquid before entering the evaporators in a single stage system. Subcooling is achieved by flashing a part of liquid in an economizer heat exchanger or flash liquid receiver vessel to the intermediate pressure level connected to screw compressor economizer port.



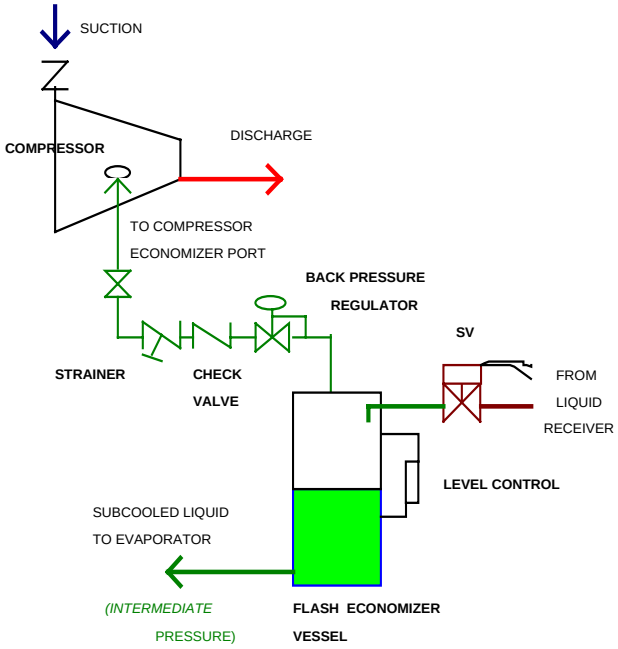
The Flash System exhibits approximately 2% better capacity increase compared to DX or Flooded Shell & Coil systems as high pressure liquid is subcooled to the saturated intermediate temperature and pressure level while other systems requires a certain temperature differential above saturated temperature.



Economizer system is only effective at compressor capacities above 45%, equivalent to compressor capacity indicator position around 35% or higher. The internal economizer port will become open to suction side as slide valve moves toward fully unloaded position. The standard microprocessor control closes the economizer liquid supply solenoid valve at 45% and below of slide valve position.

Check valve and Strainer are required for economizer system. Check valve prevents flowback of oil from the compressor through economizer port during shutdown and strainer prevents dirt from entering the compressor. Piston type check valve is preferable to a disc or butterfly type for this application. Strainer must be located nearest to the economizer inlet to protect compressor except for a stop valve for servicing.

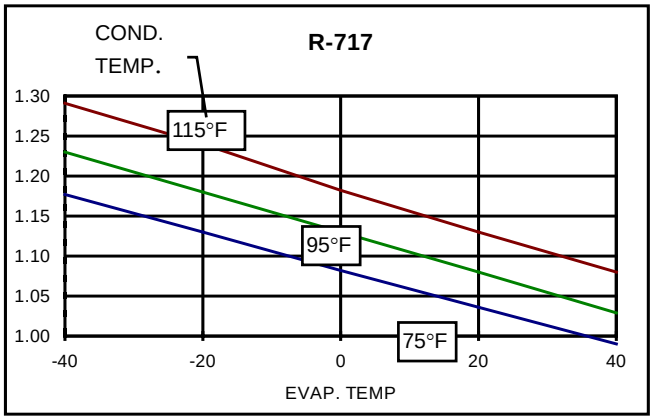
Economizer option also includes the supply of a kit consisting of a check valve, a strainer and a stop valve to be connected to external liquid subcoolers.



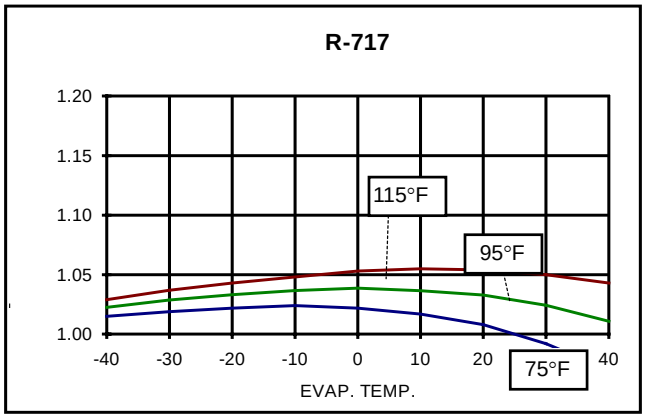
FLASH ECONOMIZER system requires Back Pressure Regulator Valve(s) to maintain intermediate pressure when compressors are unloaded to prevent insufficient pressure differential between economizer flash tank and evaporators. To minimize the flashing of subcooled liquid, generously sized and insulated liquid line is necessary. A liquid recirculating pump may be necessary to overcome pressure drop and head pressure in the system. This system can be used for both single and multiple compressor applications.

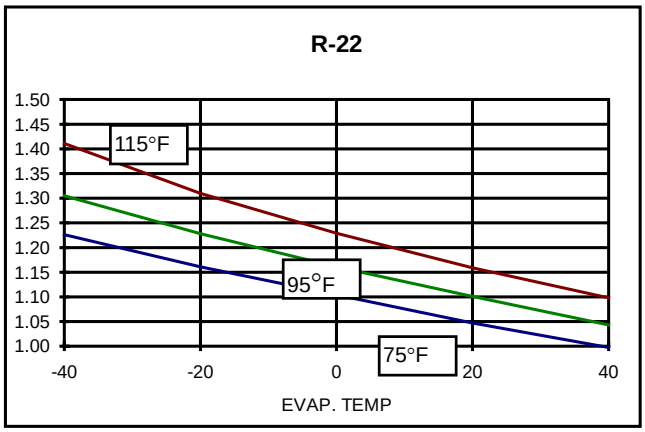
CAPACITY/BRAKE HORSE POWER CORRECTION FACTOR

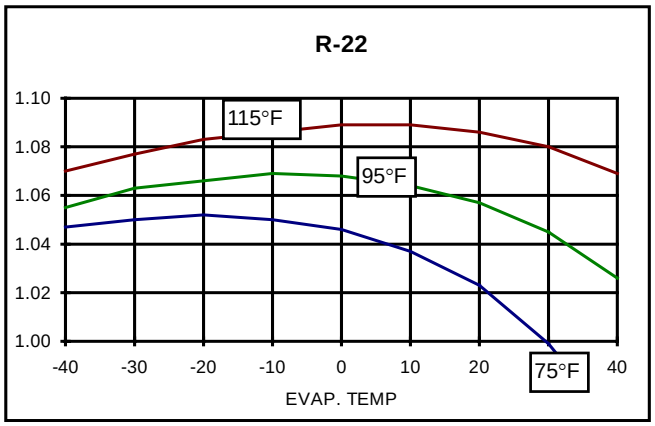
CAPACITY INCREASE (TR)



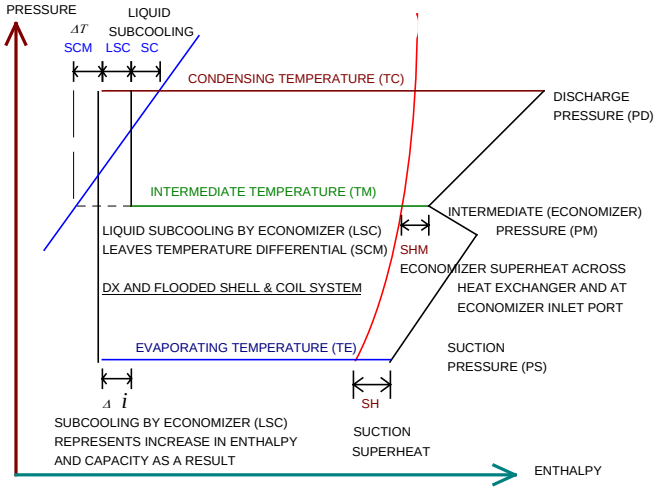
BRAKE HORSE POWER (HP)



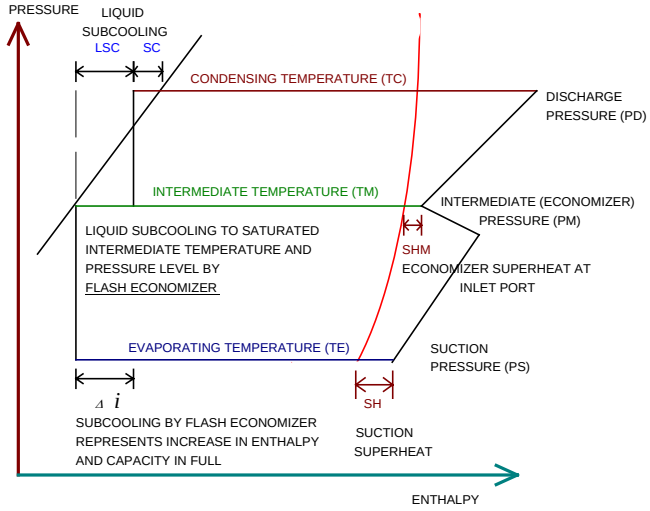




Water-cooled or Thermosyphon oil cooler 10°F Liquid Subcooling 0°F Suction Superheat
10°F Subcooled liquid above intermediate temperature DX Shell & Tube Liquid Subcooler



DX AND FLOODED SHELL & COIL SYSTEM

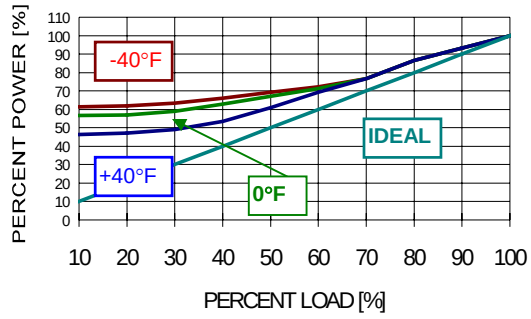


FLASH ECONOMIZER SYSTEM

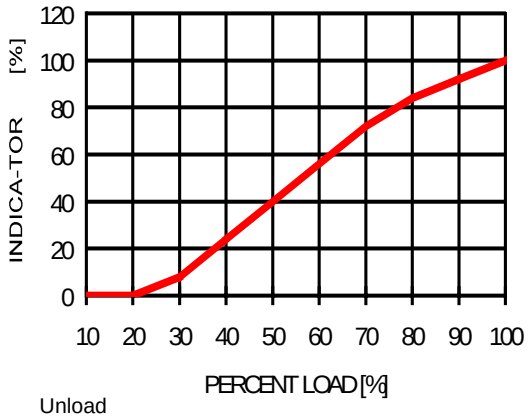
PART LOAD PERFORMANCE

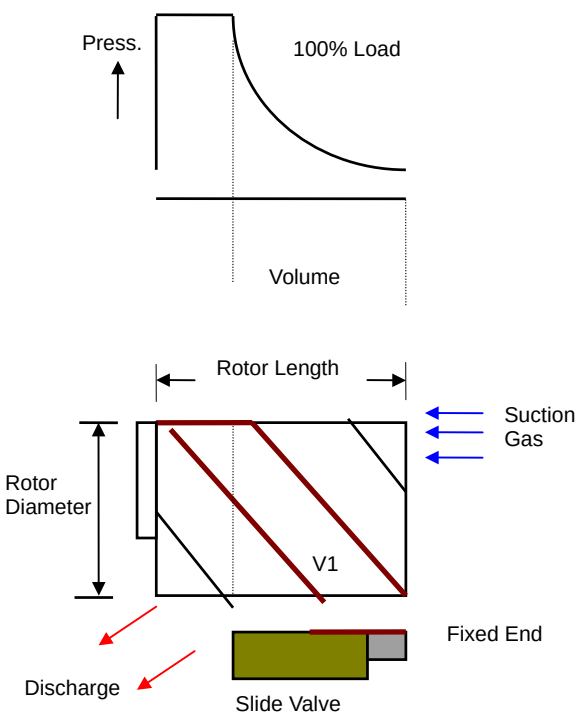
"V" series screw compressors have an internal slide valve mechanism for infinite capacity control down to 10% of capacity and unloaded starting.

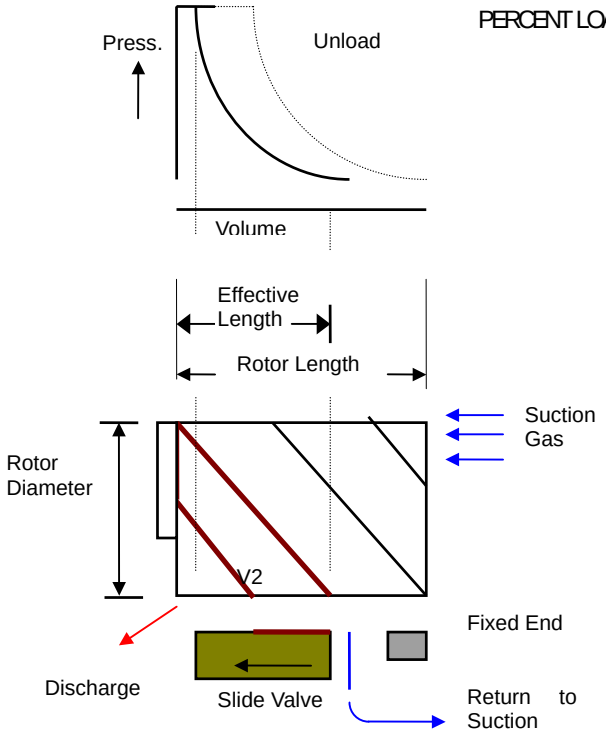
LOAD POWER INPUT
CONSTANT DISCHARGE PRESSURE



UNLOADER INDICATOR







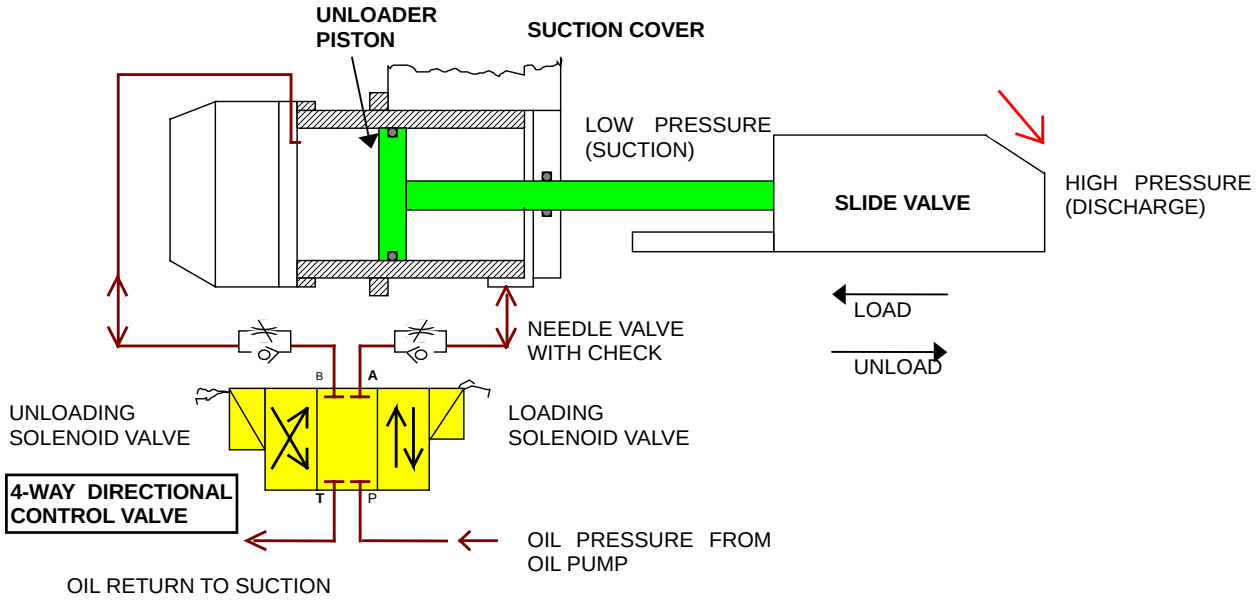
- The slide valve moves axially and parallel to the compressor rotors and alters the working length of rotors being used for compression. The action of the slide valve provides an opening for the suction gas trapped between rotors and casing to return to internal suction manifold before compression phase begins.
- The amount of gas returned is in direct proportion to the position of the slide valve, thus stepless modulation of compressor capacity is achieved with minimal work recycling the trapped gas through suction chamber.
- The position of the slide valve is indicated on the external unloader indicator located at the end of hydraulic cylinder. The scale of unloader indicator represents the percent of slide valve axial stroke and not the percent of capacity.

- Total power requirement is the sum of:

1) Gas compression
2) Agitation of injected oil
3) Mechanical friction loss
4) Re-compression of blow-by gas through interlobe space

(2) thru (4) remain relatively constant at part load.

SCREW COMPRESSOR UNLOADER MECHANISM



The function of the capacity control is to vary the compressor capacity by means of the slide valve in accordance with the system load requirement. Any time the compressor capacity deviates considerably from the system load, the operating conditions will become unsatisfactory.

For re-establishing system equilibrium at the design operating conditions, "V" series packages employ PID - time proportioning control system built in standard microprocessor control and 4-way directional control valves to actuate unloader piston hydraulically.

The system suction pressure is monitored at regular time intervals (sampling time) and when this varies by a preset amount from the set condition, the compressor capacity will be modulated by a fixed percentage of PID output value represented as certain duration of time.

The pressure difference across the slide valve (discharge and suction) results in unbalanced loading (fast) and unloading (slow) speeds that causes unbalance between slide valve movement and PID control output. The needle valves are furnished to adjust this speed to achieve stable capacity.

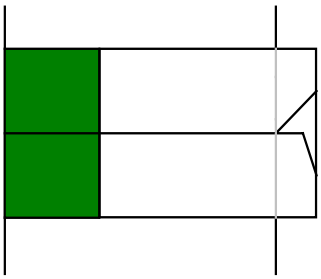
MICROPROCESSOR CONTROL SCREEN

	SET	
DEAD BAND	[2.5]	PSIG
P.BAND (%)	[60.0]	
SAMPLING TIME	[10.0]	Secs
INTEGRAL TIME	[60.0]	Secs
DERIVATIVE TIME	[0.0]	Secs
MVH (%)	[100.0]	
MVL (%)	[15.0]	

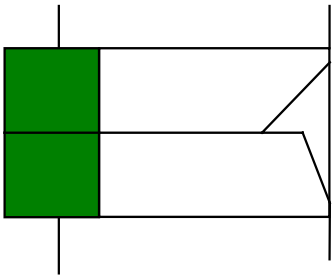
The slide valve capacity control is inactive in this dead band zone.
Proportional bandwidth, narrower is more responsive to deviation value
The smaller the sampling time interval is, the faster the response
Sets maximum (100%) duration of time for responsive range
Normally set to "0" to disable derivative time control
Slide valve maximum % position. Set to 100%
Slide valve minimum % position. Set to 15% or higher to prevent compressor from running at fully unloaded position continuously.

VARIABLE Vi

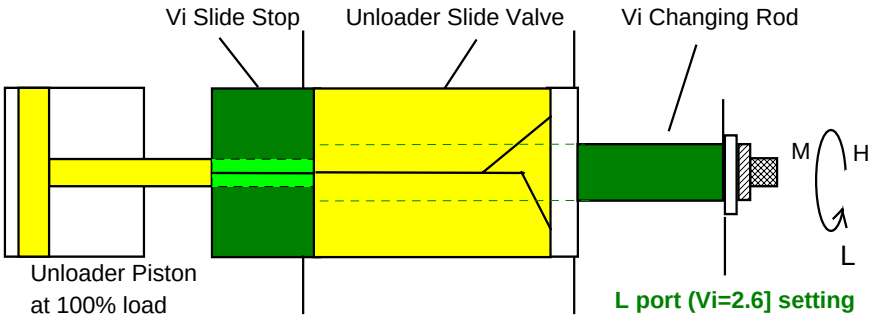
The Vi of conventional fixed Vi screw compressor is determined by the combination of axial discharge port of the rotors on the bearing head and the radial discharge port of the shaft (radial discharge port on the [Unloader Slide Valve]). The axial and radial elements are combined so as to exhibit particular characteristics at partial load. In the case of V series, the Vi can be changed by altering the size of the radial port while maintaining the axial port at Vi=5.10. [Vi Slide Stop] is fixed to [Vi Changing Rod] extending toward the opposite end of [Unloader Piston] that actuates [Unloader Slide Valve]. Vi change is made possible by rotating the [Vi Changing Rod] that moves the stop position of [Vi Slide Stop] toward discharge side and changes Vi by reducing the size of the radial port at fully loaded operation when rotating the rod clockwise. The number of turns depends on compressor model and Vi.



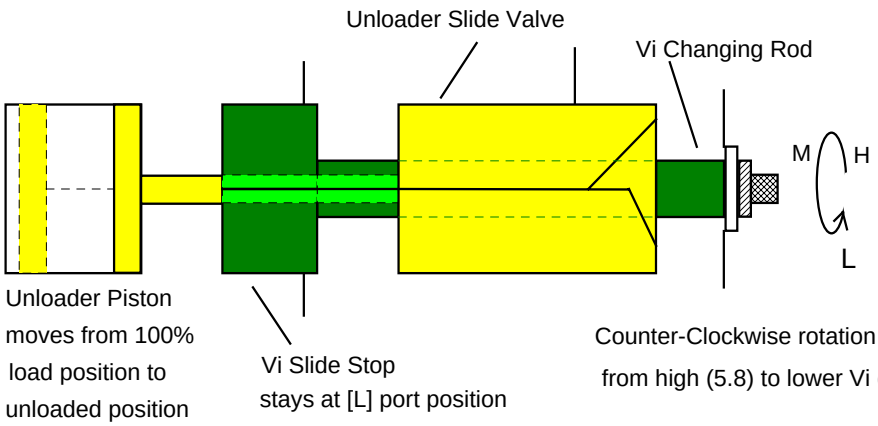
H port [Vi=5.8] setting



M port [Vi=3.6] setting



L port (Vi=2.6] setting



Counter-Clockwise rotation changes Vi from high (5.8) to lower Vi (3.6 or 2.6)

H → M	160VSD	160VMD	160VLD
Distance	23/32”	29/32”	1-1/16”
Turns	7.2	9.9	10.8
H → M	**200VSD**	**200VMD**	**200VLD**
Distance	29/32”	1-3/32”	1-11/32”
Turns	6.6	8.0	9.7
H → M	**250VSD**	**250VMD**	**250VLD**
Distance	1-1/8”	1-7/16”	1-11/16
Turns	7.3	9.1	10.8
H → M	**320VSD**	**320VMD**	**320VLD**
Distance			
Turns	13	11	10
H → M	**400VSD**	**400VMD**	
Distance			
Turns	8.4	10.6	
H → L	**160VSD**	**160VMD**	**160VLD**
Distance	1-15/32”	1-25/32”	2-5/32”
Turns	14.0	18.0	22.0
H → L	**200VSD**	**200VMD**	**200VLD**
Distance	1-13/16”	2-1/4”	2-23/32”
Turns	13.0	16.0	19.0
H → L	**250VSD**	**250VMD**	**250VLD**
Distance	2-9/32”	2-27/32”	3-7/16”
Turns	14.0	18.0	21.0
H → L	**320VSD**	**320VMD**	**320VLD**
Distance			
Turns	21.5	21.5	23
H → L	**400VSD**	**400VMD**	
Distance			
Turns	14.0	18.0	

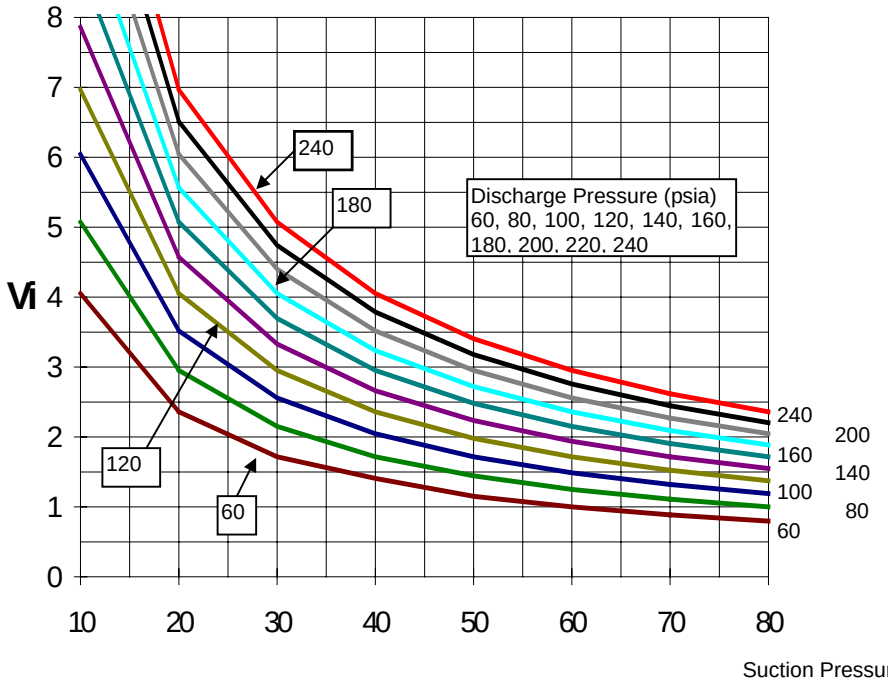
HOW TO CALCULATE Vi

When the gas volume trapped between suction rotor lobes is decreased to the designed volume ratio (Vi) , the rotor lobes are linked to the discharge outlet port and the gas is discharged. Vi is the ratio of interlobe space after completion of suction to the volume when the discharge port opens.

$$Vi = \frac{\text{Volume of trapped gas when compression begins}}{\text{Volume of the same amount of gas when discharge begins}} = \left(\frac{Pd}{Ps}\right)^{\frac{1}{k}} = (CR)^{\frac{1}{k}}$$

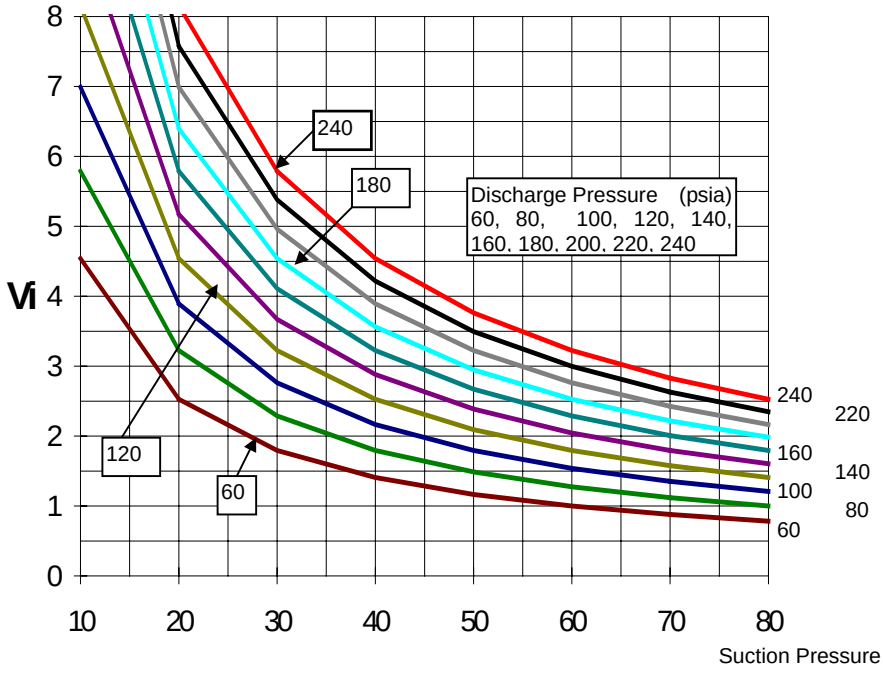
Pd	*Discharge pressure*
Ps	*Suction pressure*
k	*Specific heat ratio*
CR	*Compression ratio*

AMMONIA / R-717



$$Vi = \left(\frac{Pd}{Ps}\right)^{\frac{1}{1.28}}$$

R-22

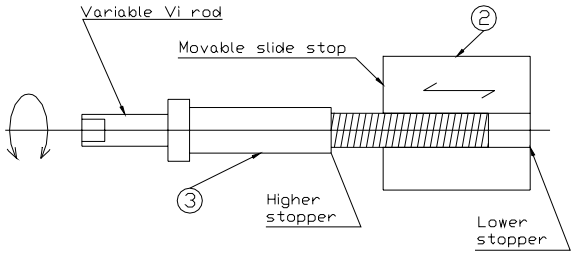


$$Vi = \left(\frac{Pd}{Ps}\right)^{\frac{1}{1.184}}$$

Step 1 Obtain n; required rotating number (360 turns) of variable Vi rod ③.

Model	H to M 5.8 to 3.6	H to L 5.8 to 2.6
160VSD	7	15
160VMD	9	19
160VLD	11	22
200VSD	6.5	13
200VMD	8	16.5
200VLD	9.5	20
250VSD	7	14.5
250VMD	9	18
250VLD	10.5	23
320VSD		
320VMD		
320VLD		

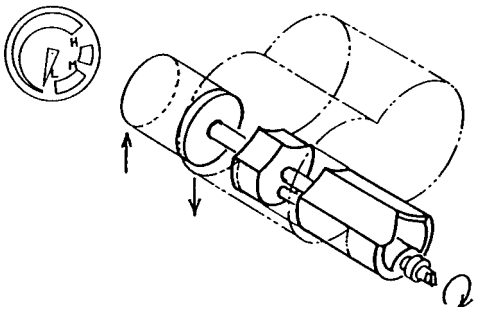
Number of rod rotations: n



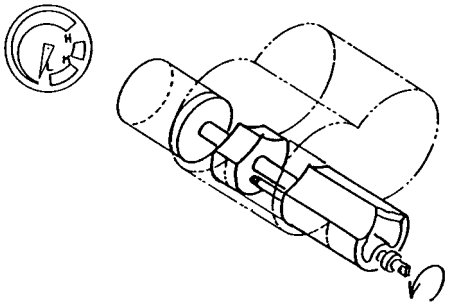
Step 2 Unload slide valve position to 0% by using the unloader piston.

Step 3 Remove domed cap nut and loosen hexagon nut.

Step 4 Rotate the variable Vi rod ③ clockwise, until stopper contacts movable slide stop ②, then Vi is H.

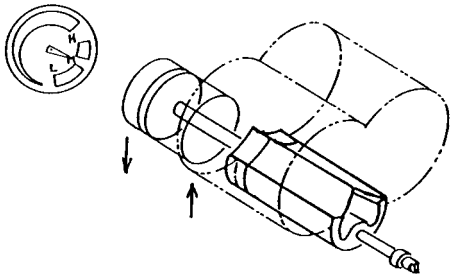


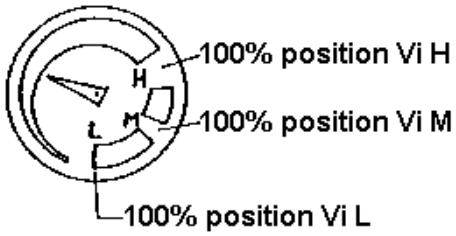
Step 5 Rotate the variable Vi rod ③ counter-clockwise to n turns from Step 1.



Step 6 Tighten the hexagon nut and domed cap nut.

Step 7 Load the slide valve to the 100% position by using the unloader piston, and check built-in volume ratio was adjusted correctly on capacity indicator.





Capacity indicator showing 100% position of each Vi.

Note: Indicated position will vary slightly depending on the compressor models.

Caution: The adjustable Vi rod (3) must be rotated with less than 200 Kg•cm torque.

Precautions when changing Vi.

- The Vi should be changed only when the compressor is stopped and the capacity control mechanism is set to the no-load position.

- Unreasonable force should not be applied to the mechanism provided when turning the adjustment screw

V-SERIES COMPRESSOR OPERATING LIMITS

DESCRIPTION	VALUE	UNIT	METRIC	UNIT
Maximum Discharge Pressure	313	psig	22	Kg/cm^2G
Maximum Suction Pressure	85	psig	6	Kg/cm^2 G
Minimum Suction Pressure	23	in Hg	600	mm Hg
Minimum Pressure Differential	15	psi	1	Kg/cm^2
Minimum Oil Pressure Differential	20	psi	1.4	Kg/cm^2
Design Oil Temperature - External Oil Cooler	130	°F	55	°C
- Liquid Injection Oil Cooling	140	°F	60	°C
Maximum Oil Supply Temperature	160	°F	70	°C
Minimum Oil Temperature	70	°F	20	°C
Maximum Discharge Temperature	200	°F	95	°C
Maximum Speed 125UD, 160V ~ 250V	4500	RPM	4500	RPM
320V, 400V	3600	RPM	3600	RPM
Minimum Speed	1450	RPM	1450	RPM
Compressor Housing Hydraulic Test Pressure	470	psig	33	Kg/cm2G
Compressor Housing Pneumatic Test	313	psig	22	Kg/cm2G
Refrigerant	Ammonia	R23		
	R22	HP62		
	R134a	Propane		

V-SERIES COMPRESSOR NOISE LEVEL & VIBRATION

Noise and vibration tests are carried out in the Mycom Compressor Factory prior to the shipment in order to check whether the compressor's noise and vibration are within the standard values.

Noise Level

Noise level is measured with noise meter defined in Japanese Industrial Standard (JIS) C1502: Ordinary Noise Meter according to JIS B8346: "Testing Method for Blower and Compressor Noise Levels".

MYCOM Standard "Not-To-Exceed" value

SINGLE STAGE	dB(A)	COMPOUND 2-STAGE	dB(A)
125S	84	1612C	86
125L	84	2016C	87
160S	84	2520C	92
160M	84	3225C	98
160L	85		
200S	86		
200M	87		
200L	88		
250S	88		
250M	90		
250L	90		
320S	95		
320M	97		
320L	98		
320LL			

* Measured at 1 meter (3.3 feet) distance shown as point "A".

Instrument used: Standard Noise Meter type NA-09 by Rion Co., Ltd. 1 dB allowance.

Vibration

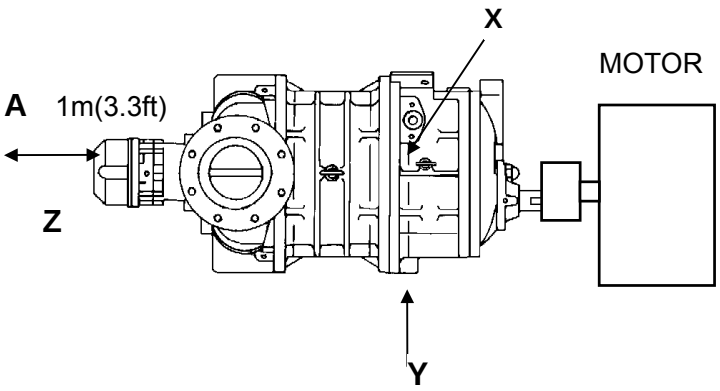
Amplitude of vibration is measured with general-purpose vibrometer.

MYCOM Standard "Not-To-Exceed" value
0.79 mils (20 μm)

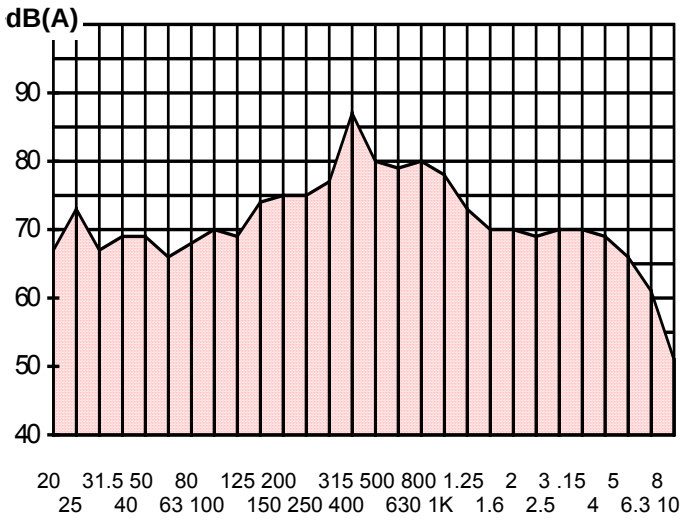
* Value of half-amplitude measured at points shown as "X", "Y" and "Z".

Frequency range: 10 to 400 Hz (CPM)

Instrument used: General purpose vibrometer
Type: VM-20A by Rion Co., Ltd. 1μm allowance.



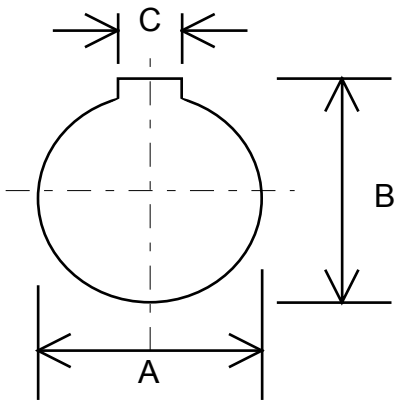
Frequency Spectrum
1/3 Center Octave Band



MODEL: 200L 2950rpm
100% loaded Ammonia

V-SERIES COMPRESSOR COUPLING BORE & ALLIGNMENT

Model	Compressor Shaft	A	B	C	Standard Coupling
125	$38^{+.000}_{-.016}$ (mm)				8CH
	$1.4961^{+.0000}_{-.0006}$	1.4970 1.4965	1.6430 1.6410	.3947 .3937	
160	$45^{+.011}_{-.005}$ (mm)				9CH
1610/12	$1.7717^{+.0004}_{-.0002}$	1.7730 1.7725	1.9170 1.9150	.4734 .4724	
200	$55^{+.012}_{-.007}$ (mm)				10CH
2016	$2.1654^{+.0005}_{-.0003}$	2.1668 2.1663	2.3690 2.3670	.5916 .5906	
250	$67^{+.012}_{-.007}$ (mm)				11CH
2520	$2.6378^{+.0005}_{-.0003}$	2.6390 2.6385	2.8790 2.8770	.7097 .7087	
320	$85^{+.011}_{-.000}$ (mm)				
3225	$3.3465^{+.0004}_{-.0000}$	3.3479 3.3475	3.6680 3.6660	.9459 .9449	



MYCOLD-AB68 SYNTHETIC REFRIGERATION COMPRESSOR LUBRICANT

DESCRIPTION:

Mycold AB-68 Synthetic Refrigeration Compressor lubricant is formulated from the highest quality alkylate base stocks. It is recommended for all types of refrigeration compressors including reciprocating, centrifugal and rotary types using fluorocarbon or ammonia refrigerants. Mycold AB is recommended for service where evaporator temperatures may be lower than -50°F and where improved performance and reliability is desirable.

APPLICATIONS:

All refrigeration compressor types including screw, reciprocating, centrifugal and rotary, using fluorocarbon refrigerants such as R12, R22, R114, R502 as well as ammonia, in both Industrial and Marine applications. Compatible with conventional mineral oils and materials of construction including Mylar® , Polypropylene, Viton®, Buna-N, Neoprene®, and Nylon® elastomers.

PERFORMANCE BENEFITS:

- Improved compressor efficiency
- Excellent high temperature stability
- Superior solubility characteristics with refrigerants
- Excellent compatibility with materials of construction
- Outstanding low temperature properties
- Improved wear protection at elevated temperatures
- No deposit formation in low temperature systems
- Extended service life and longer drain intervals
- High degree of chemical stability
- Eliminates degradation and sludge formation associated with conventional mineral oils

Prevents fouling of heat surfaces and plugging of evaporators and expansion valves

LUBRICANT TYPICAL PROPERTIES:

SPECIFICATIONS	UNIT	METHOD	AB-68	(°F)
ISO Grade			68	
Specific Gravity @ 60°F (min)		D-1250	0.86	
Viscosity @ 40°C (104°F)	cSt	D-445	65	
Flash Point (min)	°C	D-92	165	329
Floc Point (max)	°C	ASHRAE	-55	-67
Pour Point (max)	°C	D-97	-35	-31
Water (max)	ppm	D-1533	30	
Dielectric Strength (min)	kV,	D-877	30	
Shell 4-Ball Wear	mm²	D-2266	0.4	
Falex Wear Test pin wear	mg	D-2760	15	
Color (max)		D-1500	1.0	
Total Acid No.	mg KOH/g	D-974	NIL	

Notes: (1) Not for application with HFC refrigerants (2) Contact MYCOM for lubricants compatible with R134a

MYCOM OIL PUMP

MYCOM Oil Pump is a Double-Helical Screw Gear Pump manufactured by MYCOM with the same technology as MYCOM Screw Compressors. High efficiency is obtained by advanced “no-thrust load” rotor profile design and double helical screw rotors design that can reduce required motor size always smaller than conventional gear pumps.

Main features

- Industry-proven durability with no thrust load screw gear structure.
- Low noise, low vibration
- High efficiency, less break horse power required
- Reliability and extended service life
- Variable speed makes easy pump selection
- Integral pressure-regulating valve which allows simpler lube system.
- Open type (MP series), C-flange type (FP series) available.
- Cast steel casing is available as an option

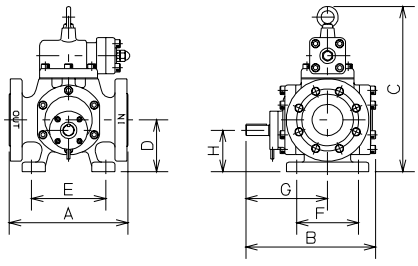
Features

Model	MP50	MP60	MP80	MP100	FP50	FP60
Speed Maximum [rpm]	1750	1750	1750	1750	1750	1750
Minimum [rpm]	950	950	950	720	950	950
Rotation direction *	CW	CW	CW	CCW	CCW	CCW
Std Flow direction *	R → L	R → L	R → L	R → L	R → L	R → L
Max. outlet pressure (psig) *	313	284	313	313	284	284
(kg/cm2G)	22	20	22	22	20	20
Min. inlet pressure (psig)	-4.3					
(kg/cm2G)	-0.3					
Max. inlet temperature F *(C)	176 (80)					
Viscosity of fluid (cst)	3～500					
Oil strainer before the pump	#100 mesh or finer					

Notes:

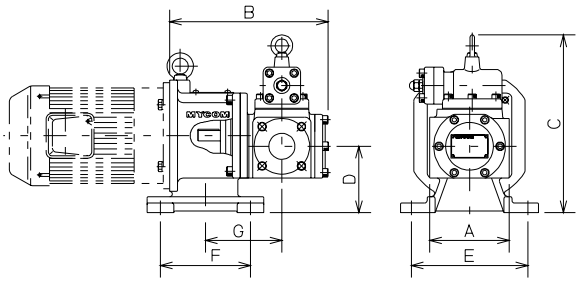
- Maximum relief capacity of the integral pressure-regulating valve is 50% of total flow
- Mycom can build reverse rotation and reverse flow direction pumps at the same cost.
- High temperature (up to 266 F) oil pumps are available as option.
- High pressure (up to 355 psig) oil pumps are available as option.

MP-Series dimension (in mm)



	A	B	C	D	E	F	G	H
M50P	230	251. 5	320	100	144	120	158. 5	80
M60P	230	295	330	100	144	120	192	80
M80P	330	382	495	150	200	160	235	118
M100P	490	476	588	220	290	210	305	190

FP-Series dimension (in mm)



	A	B	C	D	E	F	G
F50P	150	300	335	125	220	170	144
F60P	230	358	355	125	220	200	175. 5

COMPRESSOR CONTROL PANEL

The MYCOM **MYPRO-M** microprocessor control panel is factory assembled, mounted and wired on each package to provide safety and efficient automatic control and monitoring of compressor package.

Hardware

The MYPRO-M control is a microprocessor- based microcomputer in compliance with UL and CSA requirements. Microprocessor board is designed around HD64180 VSLI microprocessor operating at 6.12 MHz. This microprocessor supports up to 12 levels of vectored interrupts and features direct memory access, memory management, interrupts control, dual counter channels, dual asynchronous communication channels and a clocked serial input/output channel. Circuits are housed in NEMA 4 enclosure. The keypad and display are two components for operator interface. 640 x 480 Pixel Liquid Crystal with CCFL backlit display is standard. It is easy to read without light in the compressor room. Display includes battery backed real time clock. Both solid-state memory and RTC are battery backed to prevent data loss during shut down or temporary loss of power. The standard MYPRO-M series contains 16 analog input and 16 digital input/output board that can be expanded to 32 channels depending on application software. All the boards, keypad and display are connected with ribbon cable and built in module. MYPRO-M control panel can operate as a stand-alone or networked with other MYPRO control group and on-site monitoring PC with communication cable.

Software

MYCOM has developed MYPRO-M compressor control software for versatile applications including single stage, booster, economizer, compound two-stage, manual adjustable or automatic variable Vi.

Data Entry

Data entry is user-friendly menu driven, in plain English with formats to guide operators to make any changes or initial set up. All necessary parameters are shown on the same screen for easy entry.

Status Menu

The status screen shows all the analog inputs, capacity and conditions of operating packages. Unit is user selectable to suit worldwide applications. This screen shows up automatically whenever power is on or keypad is not touched for set time.

Operation Mode

Users can select operation modes among "*manual", "auto local", "auto remote", and "manual remote"* as standard. Auto remote capacity control is option.

Alarm and Failure History Log

MYPRO-M records all alarms and failures whenever an event happens on the package. All the operating parameters, date and time are recorded at the time of event.

Operation History and Trend Log

The trend log displays complete status screen every 15 minutes and stores most recent 2 days operating parameters.

Power Consumption & Demand Reading

Total run time, daily power consumption and total power consumption are stored for easy energy management.

Compressor Operation Scheduler

The compressor operation can be scheduled by setting the scheduler for time and day of the week mode with different and by multiple suction pressure settings.

Password Protection:

There is multi-level password protection for user modifiable operating parameters.

Sensor Compensation

Software provides user adjustable sensor compensation for easy and accurate pressure and temperature calibration.

REMOTE CAPACITY CONTROL

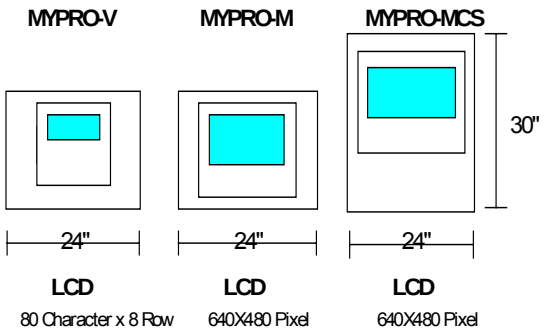
accepts remote load/unload, compressor start/stop commands and feeds back unloader slide valve position through isolation amplifiers

AUTO STAGING CONTROL

runs multiple compressors in a sequential order using RS-485 port among designated lead/lag machines that can be swapped automatically in case of a failure

OPERATOR CONSOLE COMMUNICATION

is a one-on-one and one-way compressor to computer communication using PC as an ANSI terminal for remote monitoring purposes only



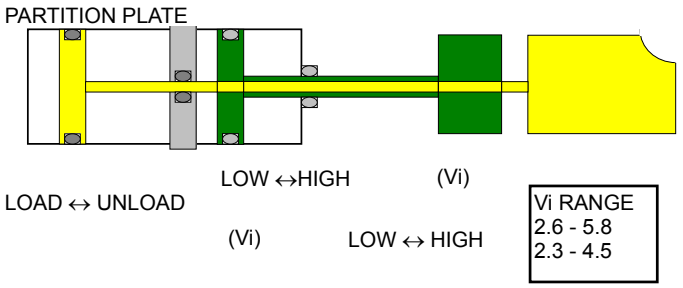
PC NETWORK W/ GRAPHICS
runs on multiple machines using RS-485 serial ports and interfacing a designated gateway panel to the customer's computer with graphics software for remote monitoring, data logging and report generation.

THIRD PARTY PROTOCOL
is the communication software based on Token Bus protocol using RS485 serial ports connected to customer's control equipment. MYCOM provides documentation and technical support

CHILLER CONTROL KIT
requires **MCS** or **M** panel with digital I/O expansion board. Chiller Kit-2 includes condenser water temperature reading and Analogue I/O expansion board.

Automatic Variable Vi Control
Unlike "V" series manually adjustable variable Vi screw compressors, "Vi" series screw compressors are designed to modulate Vi (internal volume ratio) automatically during operation. The slide valve mechanism is constructed in two sections, Vi slide stop and Unloader slide valve. Both slide valves are modulated individually by two

Microprocessor
MYPRO-V series control panel handles automatic Vi control as a variation to standard single stage and two-stage systems. The applicable range of Vi is divided into appropriate number of control steps in order to avoid unnecessary fluctuations and offsets. The initializing process of automatic Vi control for different compressor models and Vi ranges is fully automated by the control system.



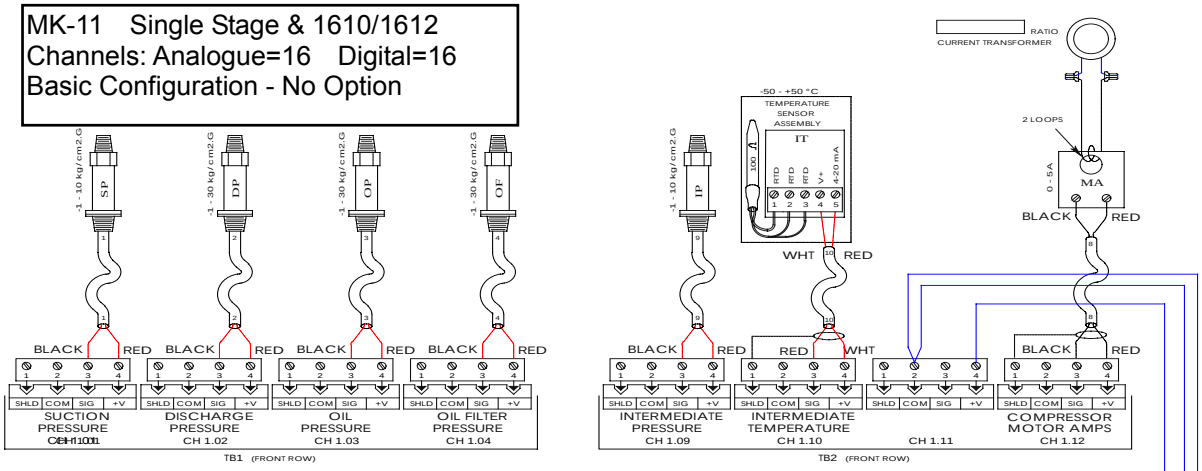
MICROPROCESOR CONTROL OPTIONS

A/D: Analogue/Digital I/O channels

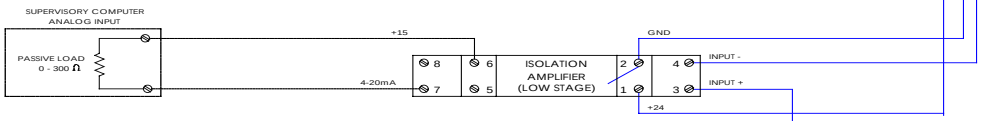
ITEM	DESCRIPTION	[BOX TYPE]	TYPE	A/D	APPLICATION
	MYPRO-V (Old model)	[K]	V-K-11	16/16	Single stage, 2-Stage (1610-1612)
			V-K-21	16/32	2-Stage2 (2016-3225), Auto Vi, Remote
	MYPRO-M (Standard)	[K]	M-K-11	16/16	Large LCD Display, Pull Down Menu
			M-K-21	16/32	2-Stage2 (2016-3225), Auto Vi, Remote
	MYPRO-MCS (Option)	[MCS]	MCS-A-11	16/16	Large Box & LCD Display, Pull Down Menu
			MCS-A-21	16/32	Chiller Kit, 2-Stage, Auto Vi, Remote
			MCS-A-22	32/32	Chiller Kit-2 w/ Condenser water temperature
SYSTEM & SOFTWARE	REMOTE CAPACITY CONTROL		RCC	16/32	Single, 2-Stage (1610 1612) w/ Isolation amp.
	REMOTE CAPACITY CONTROL		RCC2	16/32	2-Stage (2016 2520 3225) w/ isolation amp.
	AUTO STAGING CONTROL		ASC	16/32	Multiple compressor lead/lag sequencing
	MODEM COMMUNICATION		MDC		1200 Baud Modem Module w/ software
	CONDENSER CONTROL		CDC	16/32	6-Stages of fan control by discharge pressure
	OPERATOR CONSOLE COMM.		OCC		PC interface software w/ RS-232/422 port
	PC NETWORK W/ GRAPHICS		NWC		Auto staging, graphics & report generation
	THIRD PARTY PROTOCOL		TPP		Communication software for other equipment

WIRING DIAGRAM
MYPRO-M TYPE M-K-11 (A)

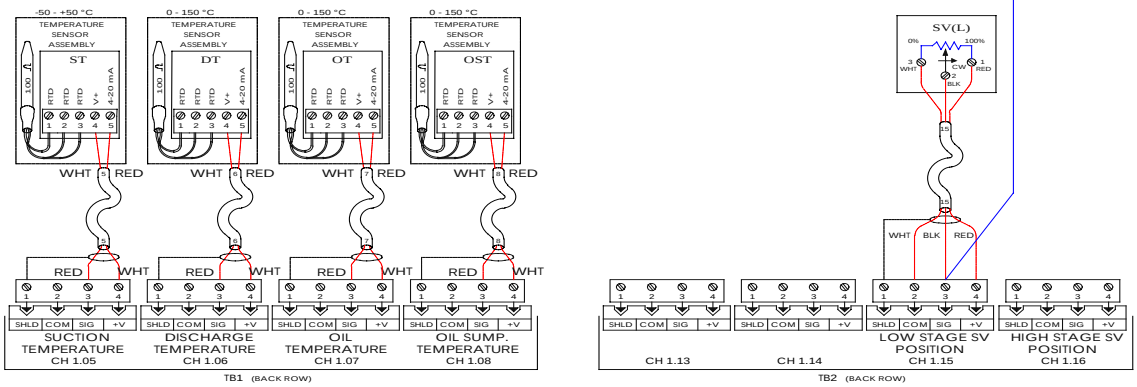
MK-11 Single Stage & 1610/1612
Channels: Analogue=16 Digital=16
Basic Configuration - No Option



ANALOG 16CH BOARD



SLIDE VALVE POSITION FEED-BACK
REMOTE CAPACITY CONTROL OPTION
SINGLE STAGE, 1610-2016 (M-K-21)

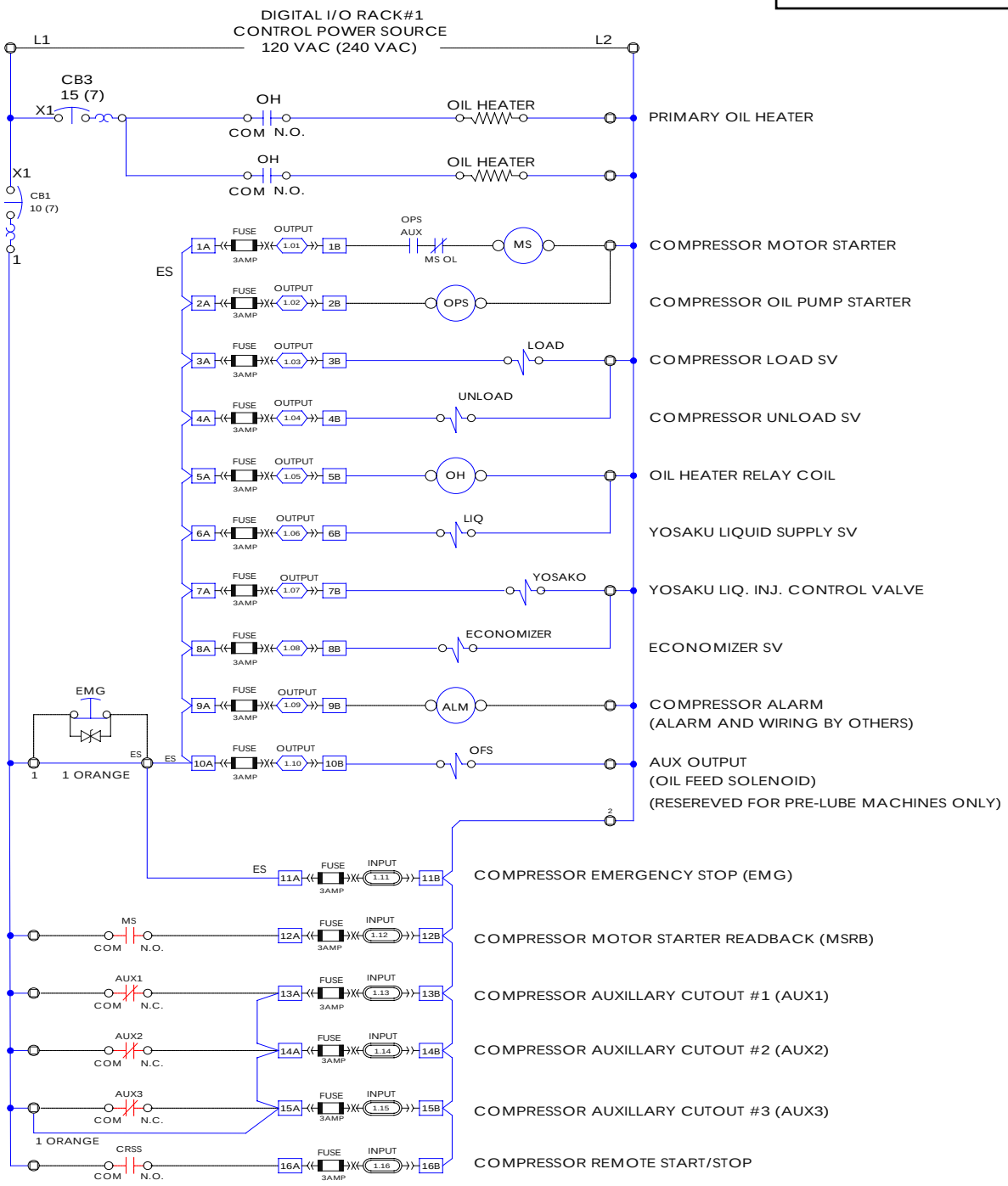


ANALOG 16CH BOARD

SLIDE VALVE POSITION

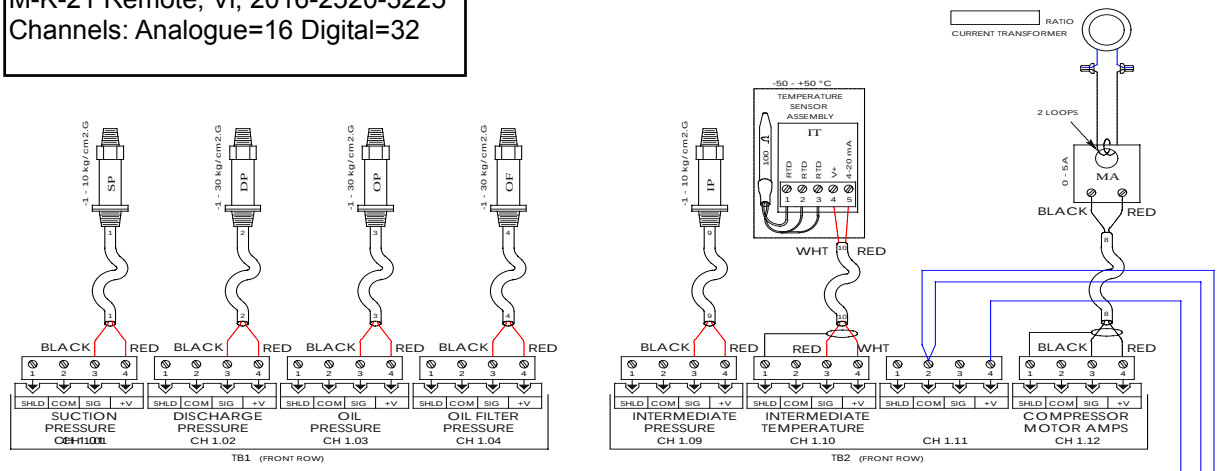
WIRING DIAGRAM
MYPRO-M TYPE M-K-11 (D)

M-K-11 Single Stage & 1610/1612
Channels: Analogue=16 Digital=16

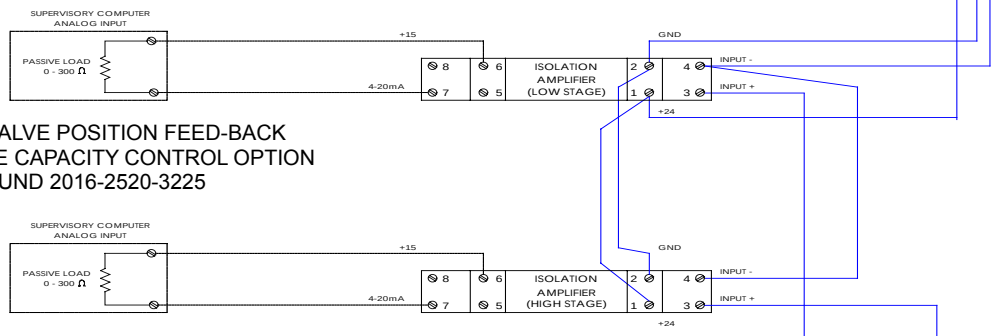


WIRING DIAGRAM
MYPRO-M TYPE M-K-21 (A)

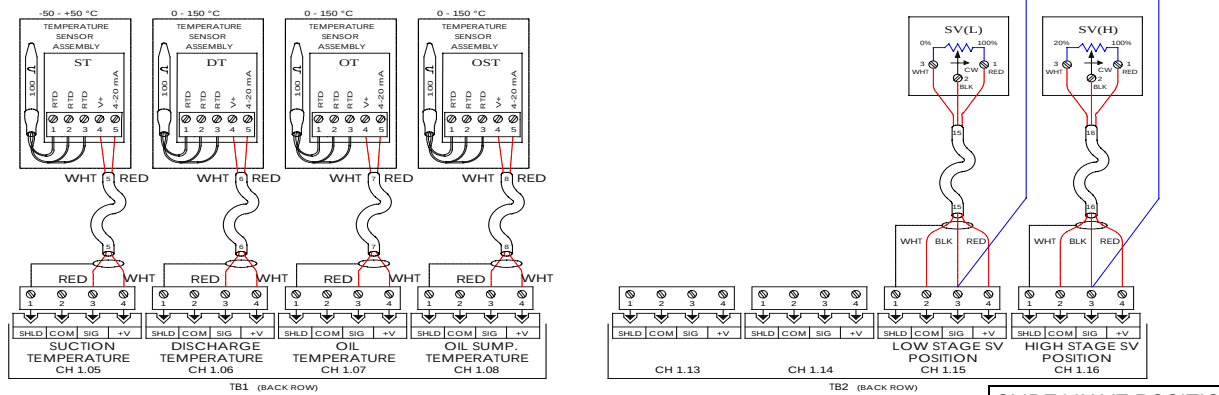
M-K-21 Remote, Vi, 2016-2520-3225
Channels: Analogue=16 Digital=32



ANALOG 16CH BOARD



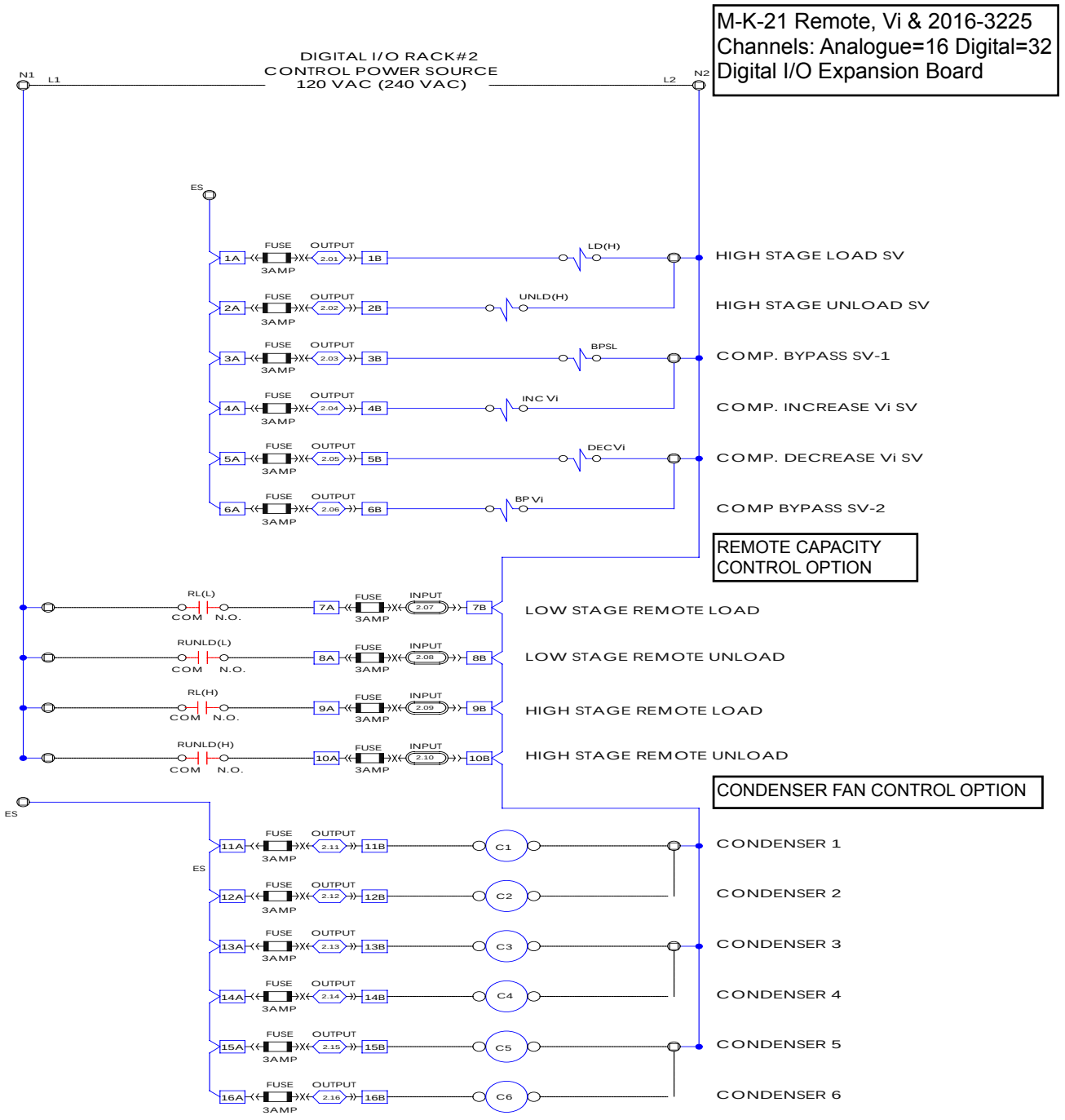
SLIDE VALVE POSITION FEED-BACK
REMOTE CAPACITY CONTROL OPTION
COMPOUND 2016-2520-3225



ANALOG 16CH BOARD

SLIDE VALVE POSITION

WIRING DIAGRAM
MYPRO-M TYPE M-K-21 (D)



COMPRESSOR MOTOR

O.D.P. STANDARD HIGH EFFICIENCY MOTOR							O.D.P. PREMIUM EFFICIENCY (EQPIII) MOTOR						
Volt	**Frame**	**S.F.**	**FLA A**	**FLT ft.lb.**	**WT (lb)**	**H.P.**	**VOLT**	**FRAME (O.D.P)**	**S.F.**	**FLA (A)**	**WT (LB)**	**EFF. EQP**	**EFF. STD**
230	326TS	1.15	146	89	510	60	230	326TS	1.15	140	594	93.6	91.7
460	326TS	1.15	73	89	510		460	326TS	1.15	70	594	93.6	91.7
575	326TS	1.15	58	89	510		575	326TS	1.15	56	594	93.6	91.7
230	364TS	1.15	176	111	530	75	230	364TS	1.15	174	615	94.1	92.4
460	364TS	1.15	88	111	530		460	364TS	1.15	87	615	94.1	92.4
575	364TS	1.15	70	111	530		575	364TS	1.15	70	615	94.5	92.4
230	365TS	1.15	230	148	590	100	230	365TS	1.15	230	713	95.0	92.4
460	365TS	1.15	115	148	590		460	365TS	1.15	115	713	95.0	92.4
575	365TS	1.15	92	148	590		575	365TS	1.15	92	713	95.0	92.4
230	404TS	1.15	294	185	840	125	230	404TS	1.15	284	1042	95.4	92.4
460	404TS	1.15	147	185	840		460	404TS	1.15	142	1042	95.4	92.4
575	404TS	1.15	118	185	840		575	404TS	1.15	114	1042	95.4	92.4
230	405TS	1.15	348	222	920	150	230	405TS	1.15	332	1115	95.8	92.4
460	405TS	1.15	174	222	920		460	405TS	1.15	166	1115	95.8	92.4
575	405TS	1.15	139	222	920		575	405TS	1.15	123	1115	95.8	92.4
230	444TS	1.15	470	295	1372	200	230	445TS	1.15	450	1403	95.8	93.6
460	444TS	1.15	235	295	1372		460	445TS	1.15	235	1403	95.8	93.6
575	444TS	1.15	120	295	1372		575	444TS	1.15	180	1403	95.8	93.6
4160	445TS	1.15	28	295	1452								
230	445TS	1.15	570	368	1440	250	230	445TS	1.15	560	1514	95.8	93.6
460	445TS	1.15	285	368	1440		460	445TS	1.15	280	1514	95.8	93.6
575	445TS	1.15	148	368	1440		575	445TS	1.15	224	1514	95.8	93.6
4160	447TS	1.15	34	368	2500								
460	445TS	1.15	340	441	1520	300	460	447TSS	1.15	340	1934	96.2	94.5
575	445TS	1.15	264	441	1520		575	447TSS	1.15	264	1934	96.2	94.5
4160	505USS	1.15	39	441	2650								
460	447TSS	1.15	390	515	1700	350	460	447TSS	1.15	390	1943	96.2	94.5
575	447TSS	1.15	310	515	1700		575	447TSS	1.15	305	1943	96.2	94.5
4160	507USS	1.15	45	515	2750								
460	447TSS	1.15	445	588	1810	400	460	505USS	1.15	445	2091	96.2	94.5
575	447TSS	1.15	316	588	1810		575	505USS	1.15	356	2091	96.2	94.5
4160	507USS	1.15	50	588	2950								
460	505USS	1.15	505	662	2650	450	460	507USS	1.15	505	2064	95.8	94.5
575	505USS	1.15	360	662	2650		575	507USS	1.15	384	2064	96.2	94.5
4160	509USS	1.15	55	662	3000								
460	505USS	1.15	560	735	2700	500	460	507USS	1.15	610	2157	96.2	94.5
575	505USS	1.15	404	735	2700		575	507USS	1.15	422	2157	96.5	94.5
4160	509USS	1.15	61	735	3150								
4160	509USS	1.00	61	735	2860								
460	507USS	1.15	665	883	2750	600	460	507USS	1.15	665	2300	96.2	94.1
575	507USS	1.15	448	883	2750		575	507USS	1.15	510	2300	96.2	94.1
4160	355L	1.15	72	883	3250								
4160	509USS	1.00	74	883	2900								
460	507USS	1.00	760	1034	3150	700	460	507USS	1.00	760	2300	95.8	94.1
575	507USS	1.00	532	1034	3150		575	507USS	1.00	632	2300	95.8	94.1
4160	355L	1.00	82	1034	3450								
4160	355L	1.00	93		3750	800							
4160	355-1000	1.00	109		4850	900							
4160	355-1120	1.00	121		5100	1000							
4160	355-1120	1.00	151		5500	1250							
4160	400-1120	1.00	330		6750	1500							

2300/4160V MOTORS USE ATL, AUTOTRANSFORMER STARTER

S.F Service Factor
FLA Full Load Amperage (Amp)
FLT Full Load Torque (ft.lb.)

3600RPM CLASS-F INSULATION
EFF: Efficiency (Nominal FL by Toshiba)
Premium Efficiency (EQPIII)
Open Drip Proof (O.D.P)

Simple Payback Analysis

Yearly Savings = (Hp x 0.746) x ($1/Eff_{Std}$ - $1/Eff_{EQP}$) x Power Cost x Hour per Year
($3,487.00) = (500Hp x 0.746) x (1/0.945 - 1/0.962) x $0.10/KWh x 5000hr
Price difference for 500HP standard eff. and EQPIII is approximately $3,000.00

MOTOR STARTER

ACROSS-THE-LINE

This starting method yields full starting torque from the motor. Standard type is Full Voltage-Non Reversing. Some restrictions are imposed with the use of full voltage starter by power utility companies and by the users.

WYE-DELTA

Starting torque is reduced to 33% of normal motor torque. Closed transition type is the standard and preferred type because open transition type may cause numerous troubles by getting out of sync with the power line during transition. This type is not recommended for booster and severe duty application.

AUTOTRANSFORMER

This is a reduced volt-age starter having three voltage taps.

Tap	% Normal torque
80%	64%
65%	42% (Default)
50%	25%

SOLID STATE

- Soft starting with selectable voltage ramp or current limit control
- Smooth stepless starting and stopping
- Reduced motor inrush current
- Reduces wear and stresses on mechanical devices.
- Eliminates line voltage drops during starting

Current Limiting type is standard. Heavy duty Step-Ramp type is recommended for Booster and severe duty applications

STANDARD SPECIFICATIONS:

♦ Combination Circuit Breaker ♦ NEMA-1 Enclosure Box ♦ Fused Starter for Oil Pump
♦ 2KVA Control Transformer ♦ Electronic Overload Protection • Phase Imbalance
♦ By-Pass Contactor (Solid State Starters only • Single Phase • Phase Loss
♦ Electronic Phase Monitor • Under Voltage • Reverse Phase

OPTIONS:

♦ Ground Fault Protection ♦ 3KVA Control Transformer ♦ NEMA-4 and NEMA-12 Enclosure Box

CURRENT TRANSFORMER (CT) RATIO - With 5A Secondary Output
CT size = [Motor Full Load Amps] x [Motor Service Factor (S.F)] x 1.25

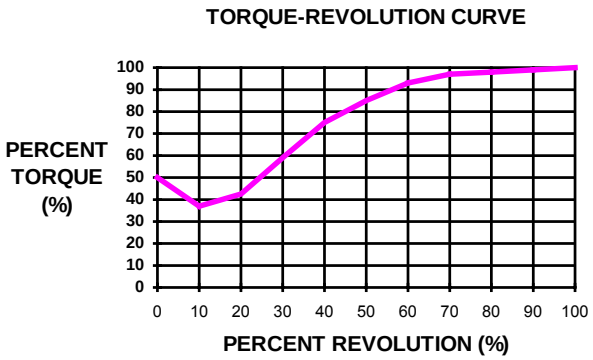
H.P.	200V	230V	380V	460V	575V	2300V	4160V
75	300	300	200	200	100		
100	400	300	200	200	200		
125	500	400	300	200	200		
150	500	500	300	300	200		
200	800	600	400	300	300	100	50
250	800	800	500	400	300	100	50
300	1000	1000	600	500	400	100	50
350		1000	600	500	400	100	100
400		2000	800	600	500	200	100
450		2000	800	800	600	200	100
500		2000	1000	800	600	200	100
600		2500	1000	1000	800	200	100
700				1000	800	200	200
800					1000	300	200
900					1000	300	200
1000					2000	300	200
1250					2000	400	200
1500					2500	500	300
1750						500	300
2000						600	400
2250						700	400
2500						700	400

COMPRESSOR STARTING TORQUE

With ordinary reciprocating compressors, the initial torque required to start revolution of the shaft is considered as “Starting Torque””. With screw compressors, starting torque is defined as the maximum torque necessary after the compressor has accelerated from the static state and reached maximum RPM. The drive motor should be selected to meet this condition.

The figure below shows general characteristic curve of revolution against torque for MYCOM screw compressors. The characteristic here is generally true for single stage and two-stage compound screw compressors.

PLEASE SEE THE ATTACHED STARTING TORQUES FOR VARIOUS MYCOM COMPRESSORS AT DIFFERENT OPERATING CONDITIONS



Remark:
Minimum output for starting is given when motor is a cage-rotor type and motor starting torque is calculated at 120%

L: Autotransformer 65% tap
Y: WYE Delta starting 33%

Single & high stage:	14°F SST	90°F SCT
Booster:	-40°F SST	5°F SIT

Start up Torque, Model 125SUD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	16	18	20	23	25	27	30	32	34	37	39	41	43	46
20	16	18	21	23	25	27	30	32	34	37	39	41	44	46
30	16	18	20	22	25	27	29	32	34	36	39	41	43	46
40		17	20	22	24	27	29	31	34	36	38	40	43	45
50		17	19	21	24	26	28	30	33	35	37	40	42	44
60			18	20	23	25	27	30	32	34	37	39	41	44
70			17	20	22	24	27	29	31	33	36	38	40	43
80				19	21	23	26	28	30	33	35	37	40	42
90				18	20	22	25	27	29	32	34	36	39	41
100					19	21	24	26	28	31	33	35	38	40

Start up Torque, Model 125LUD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	22	25	29	32	35	38	42	45	48	52	55	58	61	65
20	22	26	29	32	35	39	42	45	49	52	55	58	62	65
30	22	25	28	32	35	38	42	45	48	51	55	58	61	64
40		24	28	31	34	37	41	44	47	51	54	57	60	64
50		23	27	30	33	36	40	43	46	50	53	56	59	63
60			25	29	32	35	39	42	45	48	52	55	58	62
70			24	28	31	34	37	41	44	47	50	54	57	60
80				26	30	33	36	39	43	46	49	53	56	59
90				25	28	32	35	38	41	45	48	51	54	58
100					27	30	34	37	40	43	47	50	53	56

Start up Torque, Model 160VSD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	39	47	55	63	71	78	86	94	102	110	118	125	133	141
20	37	45	53	61	69	77	85	93	101	109	116	124	132	140
30	34	42	50	59	67	75	83	91	99	107	115	123	131	140
40		40	48	56	64	73	81	89	97	106	114	122	130	139
50		37	45	54	62	70	79	87	96	104	112	121	129	138
60			42	51	60	68	77	85	94	102	111	119	128	136
70			39	48	57	66	74	83	92	100	109	118	126	135
80				45	54	63	72	81	89	98	107	116	125	134
90				42	51	60	69	78	87	96	105	114	123	132
100					48	57	66	75	84	94	103	112	121	130

Start up Torque, Model 160VMD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	49	59	69	79	88	98	108	118	127	137	147	157	166	176
20	46	56	66	76	86	96	106	116	126	136	146	156	165	175
30	43	53	63	73	83	93	104	114	124	134	144	154	164	174
40		50	60	70	81	91	101	111	122	132	142	153	163	173
50		46	57	67	78	88	99	109	120	130	140	151	161	172
60			53	64	74	85	96	106	117	128	138	149	160	170
70			49	60	71	82	93	104	114	125	136	147	158	169
80				57	68	79	90	101	112	123	134	145	156	167
90				53	64	75	86	98	109	120	131	142	154	165
100					60	71	83	94	106	117	128	140	151	163

Start up Torque, Model 160VLD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	59	71	83	94	106	118	129	141	153	165	176	188	200	211
20	55	67	79	91	103	115	127	139	151	163	175	187	199	210
30	51	64	76	88	100	112	124	136	149	161	173	185	197	209
40		60	72	84	97	109	121	134	146	158	171	183	196	208
50		55	68	80	93	106	118	131	143	156	169	181	194	206
60			64	76	89	102	115	128	141	153	166	179	192	205
70			59	72	85	98	111	124	137	150	163	176	189	202
80				68	81	94	108	121	134	147	161	174	187	200
90				63	77	90	104	117	130	144	157	171	184	198
100					72	86	99	113	127	140	154	168	181	195

Start up Torque, Model 200VSD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	77	92	108	123	138	153	169	184	199	214	230	245	260	275
20	72	88	103	119	134	150	165	181	196	212	227	243	259	274
30	67	83	99	114	130	146	162	178	193	209	225	241	257	273
40		78	94	110	126	142	158	174	190	206	222	239	255	271
50		72	88	105	121	138	154	170	187	203	220	236	252	269
60			83	100	116	133	150	166	183	200	216	233	250	266
70			77	94	111	128	145	162	179	196	213	230	247	264
80				88	106	123	140	157	175	192	209	226	243	261
90				82	100	117	135	152	170	187	205	222	240	258
100					94	112	129	147	165	183	201	218	236	254

Start up Torque, Model 200VMD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	97	116	135	154	173	192	211	230	249	269	288	307	326	345
20	90	110	129	149	168	188	207	227	246	266	285	305	324	343
30	84	104	124	143	163	183	203	223	242	262	282	302	322	342
40		97	117	138	158	178	198	218	238	259	279	299	319	339
50		90	111	131	152	172	193	214	234	255	275	296	316	337
60			104	125	146	167	188	208	229	250	271	292	313	334
70			97	118	139	160	182	203	224	245	267	288	309	330
80				111	132	154	176	197	219	240	262	284	305	327
90				103	125	147	169	191	213	235	257	279	301	323
100					117	140	162	184	207	229	251	274	296	318

Start up Torque, Model 200VLD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	115	138	161	184	207	230	252	275	298	321	344	367	389	412
20	108	131	155	178	201	224	248	271	294	317	341	364	387	410
30	100	124	148	171	195	219	242	266	290	313	337	361	385	408
40		116	140	164	188	213	237	261	285	309	333	357	381	406
50		108	132	157	182	206	231	255	280	304	329	353	378	402
60			124	149	174	199	224	249	274	299	324	349	374	399
70			116	141	166	192	217	243	268	293	319	344	370	395
80				132	158	184	210	236	261	287	313	339	365	391
90				123	149	176	202	228	254	281	307	333	359	386
100					140	167	194	220	247	274	300	327	354	380

Start up Torque, Model 250VSD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	150	179	209	239	268	298	328	357	387	417	446	476	506	535
20	140	170	201	231	261	291	321	352	382	412	442	472	503	533
30	130	161	192	222	253	284	315	345	376	407	438	468	499	530
40		151	182	213	245	276	307	339	370	401	433	464	495	526
50		140	172	204	236	267	299	331	363	395	427	459	491	522
60			161	194	226	258	291	323	356	388	421	453	485	518
70			150	183	216	249	282	315	348	381	414	447	480	513
80				172	205	239	272	306	339	373	406	440	473	507
90				160	194	228	262	296	330	364	398	433	467	501
100					182	217	251	286	321	355	390	425	459	494

Start up Torque, Model 250VMD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	188	226	263	300	337	375	412	449	487	524	561	598	636	673
20	176	214	252	290	328	366	404	442	480	518	556	594	632	670
30	164	202	241	280	318	357	396	434	473	512	550	589	628	666
40		189	229	268	308	347	386	426	465	504	544	583	622	662
50		176	216	256	296	336	376	416	456	497	537	577	617	657
60			203	243	284	325	366	406	447	488	529	569	610	651
70			189	230	271	313	354	396	437	479	520	562	603	645
80				216	258	300	342	384	427	469	511	553	595	637
90				201	244	287	330	372	415	458	501	544	587	630
100					229	273	316	360	403	447	490	534	577	621

Start up Torque, Model 250VLD 3550rpm Unit (lbf·ft)

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	225	269	314	358	403	447	492	536	581	625	669	714	758	803
20	210	256	301	346	392	437	482	527	573	618	663	709	754	799
30	195	241	287	334	380	426	472	518	564	610	657	703	749	795
40		226	273	320	367	414	461	508	555	602	649	696	743	790
50		210	258	306	353	401	449	497	545	592	640	688	736	784
60			242	290	339	388	436	485	534	582	631	679	728	777
70			225	274	324	373	423	472	522	571	621	670	720	769
80				258	308	358	408	459	509	559	610	660	710	760
90				240	291	342	393	444	495	547	598	649	700	751
100					273	325	377	429	481	533	585	637	689	741

Start up Torque, Model 320VSD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	337	387	438	488	538	588	638	688	738	789	839	889	939	989
20	342	393	443	493	543	593	643	693	744	794	844	894	944	994
30	335	385	435	485	536	586	636	686	736	786	836	887	937	987
40		373	423	473	523	573	623	673	724	774	824	874	924	974
50		357	407	458	508	558	608	658	708	758	809	859	909	959
60			390	440	491	541	591	641	691	741	791	842	892	942
70			372	422	472	522	573	623	673	723	773	823	873	923
80				403	453	503	553	603	654	704	754	804	854	904
90				383	433	483	533	584	634	684	734	784	834	884
100					413	463	513	563	613	663	713	764	814	864

Start up Torque, Model 320VMD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	405	465	525	585	645	705	765	826	886	946	1,006	1,066	1,126	1,186
20	411	471	531	591	651	711	772	832	892	952	1,012	1,072	1,132	1,193
30	402	462	522	582	642	703	763	823	883	943	1,003	1,063	1,124	1,184
40		447	507	567	627	688	748	808	868	928	988	1,048	1,109	1,169
50		429	489	549	609	669	729	789	850	910	970	1,030	1,090	1,150
60			468	528	589	649	709	769	829	889	949	1,009	1,070	1,130
70			446	506	567	627	687	747	807	867	927	987	1,048	1,108
80				483	543	604	664	724	784	844	904	964	1,025	1,085
90				459	520	580	640	700	760	820	880	940	1,001	1,061
100					495	555	615	675	736	796	856	916	976	1,036

Start up Torque, Model 320VLD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	469	538	608	678	747	817	887	956	1,026	1,096	1,165	1,235	1,305	1,374
20	476	546	615	685	755	824	894	964	1,033	1,103	1,173	1,242	1,312	1,381
30	466	535	605	675	744	814	884	953	1,023	1,093	1,162	1,232	1,302	1,371
40		518	588	657	727	797	866	936	1,006	1,075	1,145	1,215	1,284	1,354
50		497	566	636	706	775	845	915	984	1,054	1,124	1,193	1,263	1,333
60			542	612	682	751	821	891	960	1,030	1,100	1,169	1,239	1,309
70			517	587	656	726	796	865	935	1,005	1,074	1,144	1,214	1,283
80				560	630	699	769	839	908	978	1,048	1,117	1,187	1,257
90				532	602	671	741	811	880	950	1,020	1,089	1,159	1,229
100					573	643	713	782	852	922	991	1,061	1,131	1,200

Start up Torque, Model 320LLUD 3550rpm Unit (lbf·ft)

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	561	658	756	853	950	1,048	1,145	1,243	1,340	1,437	1,535	1,632	1,730	1,827
20	558	656	753	851	948	1,045	1,143	1,240	1,338	1,435	1,532	1,630	1,727	1,825
30	556	653	751	848	946	1,043	1,140	1,238	1,335	1,433	1,530	1,627	1,725	1,822
40		651	749	846	943	1,041	1,138	1,236	1,333	1,430	1,528	1,625	1,723	1,820
50		649	746	844	941	1,038	1,136	1,233	1,331	1,428	1,525	1,623	1,720	1,818
60			744	841	939	1,036	1,133	1,231	1,328	1,426	1,523	1,620	1,718	1,815
70			742	839	936	1,034	1,131	1,229	1,326	1,423	1,521	1,618	1,716	1,813
80				837	934	1,031	1,129	1,226	1,324	1,421	1,518	1,616	1,713	1,811
90				834	932	1,029	1,126	1,224	1,321	1,419	1,516	1,613	1,711	1,808
100					929	1,027	1,124	1,222	1,319	1,416	1,514	1,611	1,709	1,806

Start up Torque, Model 400VSD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	715	856	998	1,139	1,281	1,422	1,564	1,705	1,847	1,989	2,130	2,272	2,413	2,555
20	669	813	958	1,102	1,246	1,390	1,534	1,678	1,822	1,967	2,111	2,255	2,399	2,543
30	621	768	914	1,061	1,208	1,355	1,502	1,648	1,795	1,942	2,089	2,236	2,382	2,529
40		719	869	1,018	1,168	1,317	1,467	1,616	1,765	1,915	2,064	2,214	2,363	2,513
50		668	820	972	1,125	1,277	1,429	1,581	1,733	1,885	2,037	2,189	2,341	2,493
60			769	924	1,079	1,234	1,388	1,543	1,698	1,853	2,007	2,162	2,317	2,471
70			716	873	1,030	1,188	1,345	1,503	1,660	1,817	1,975	2,132	2,289	2,447
80				819	979	1,140	1,300	1,460	1,620	1,780	1,940	2,100	2,260	2,420
90				763	926	1,089	1,251	1,414	1,577	1,739	1,902	2,064	2,227	2,390
100					870	1,035	1,200	1,365	1,531	1,696	1,861	2,027	2,192	2,357

Start up Torque, Model 400VMD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	898	1,075	1,253	1,431	1,608	1,786	1,964	2,141	2,319	2,497	2,674	2,852	3,030	3,207
20	840	1,021	1,202	1,383	1,564	1,745	1,926	2,107	2,288	2,469	2,650	2,831	3,012	3,193
30	780	964	1,148	1,332	1,517	1,701	1,885	2,070	2,254	2,438	2,623	2,807	2,991	3,176
40		903	1,091	1,278	1,466	1,654	1,841	2,029	2,217	2,404	2,592	2,779	2,967	3,155
50		839	1,030	1,221	1,412	1,603	1,794	1,985	2,176	2,367	2,558	2,749	2,940	3,131
60			966	1,160	1,355	1,549	1,743	1,937	2,132	2,326	2,520	2,714	2,909	3,103
70			899	1,096	1,294	1,491	1,689	1,887	2,084	2,282	2,479	2,677	2,875	3,072
80				1,029	1,230	1,431	1,632	1,833	2,033	2,234	2,435	2,636	2,837	3,038
90				958	1,162	1,367	1,571	1,775	1,979	2,184	2,388	2,592	2,796	3,001
100					1,092	1,299	1,507	1,714	1,922	2,130	2,337	2,545	2,752	2,960

Start up Torque, Model 400VLD 3550rpm **Unit (lbf·ft)**

Ps	Pd [PSIA]													
[PSIA]	40	60	80	100	120	140	160	180	200	220	240	260	280	300
10	Please consult with MYCOM													
20														
30														
40														
50														
60														
70														
80														
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