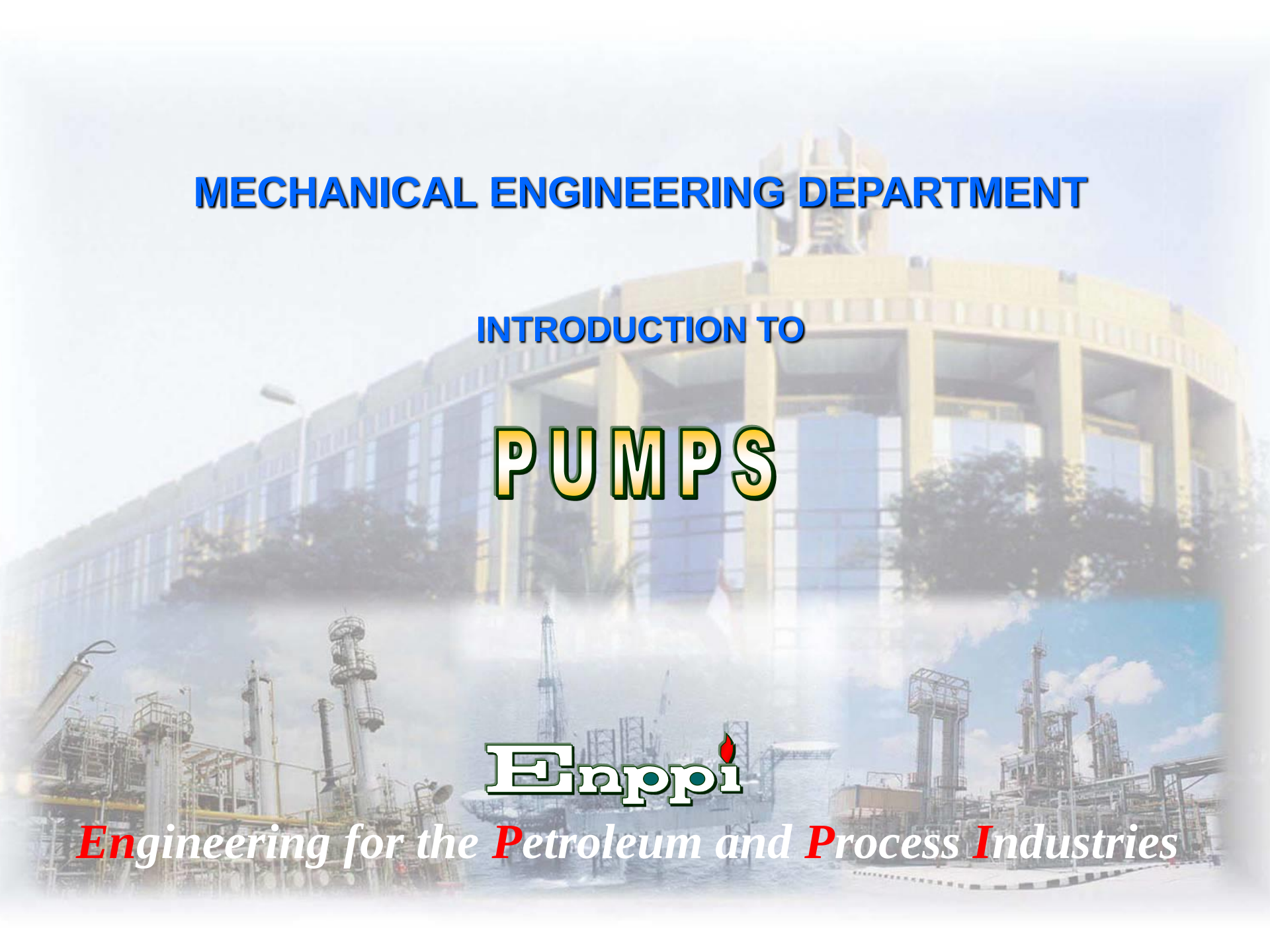


MECHANICAL ENGINEERING DEPARTMENT

INTRODUCTION TO

PUMPS

Enppi

Engineering for the Petroleum and Process Industries

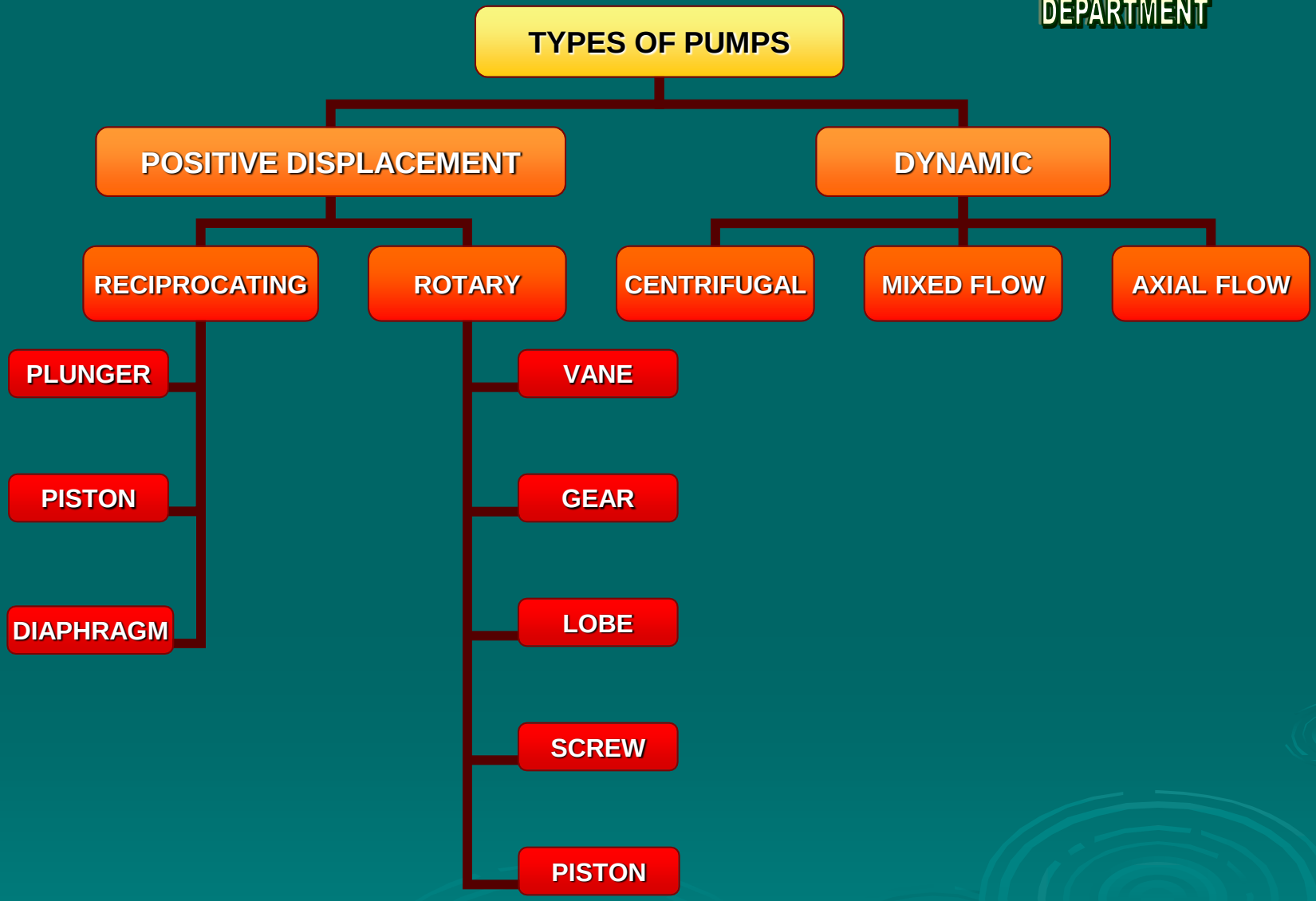
WHAT ARE PUMPS?

Pumps are machines that are used to increase the total energy level of liquid stream

CENTRIFUGAL PUMPS

PUMPS ARE USED FOR

- Moving large volumes of liquid from/to storage tanks or into pipeline
- Moving process fluid and circulating cooling water
- Providing water for fire fighting…etc.


TYPES OF PUMPS
POSITIVE DISPLACEMENT
DYNAMIC
RECIPROCATING
ROTARY
CENTRIFUGAL
MIXED FLOW
AXIAL FLOW
PLUNGER
PISTON
DIAPHRAGM
VANE
GEAR
LOBE
SCREW
PISTON

Products Storage Area

Main Process Area

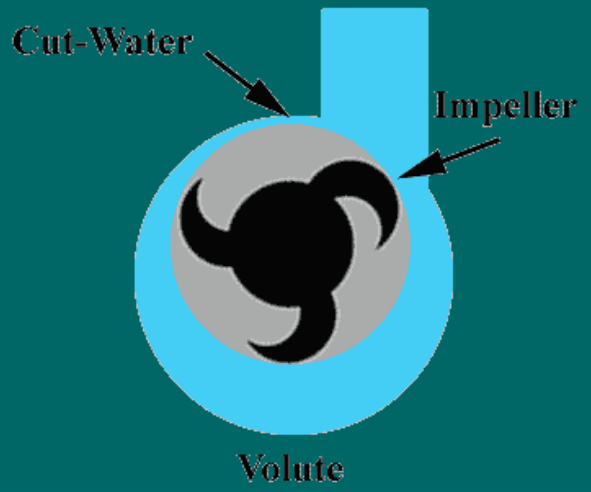
Enppi

CENTRIFUGAL PUMPS

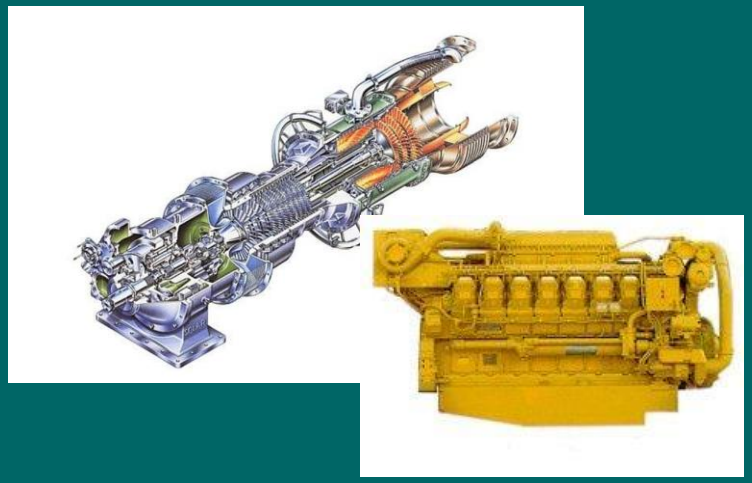
CENTRIFUGAL PUMPS OPERATING PRINCIPAL

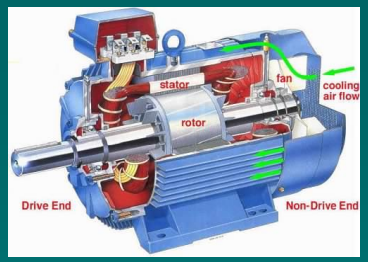
- The two main components of a centrifugal pump are the ***impeller*** and the ***volute***.

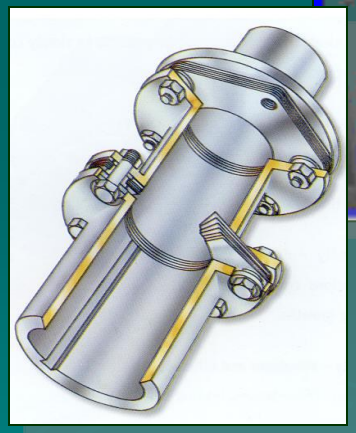
- The impeller produces liquid velocity and the volute forces the liquid to discharge from the pump converting velocity to pressure.



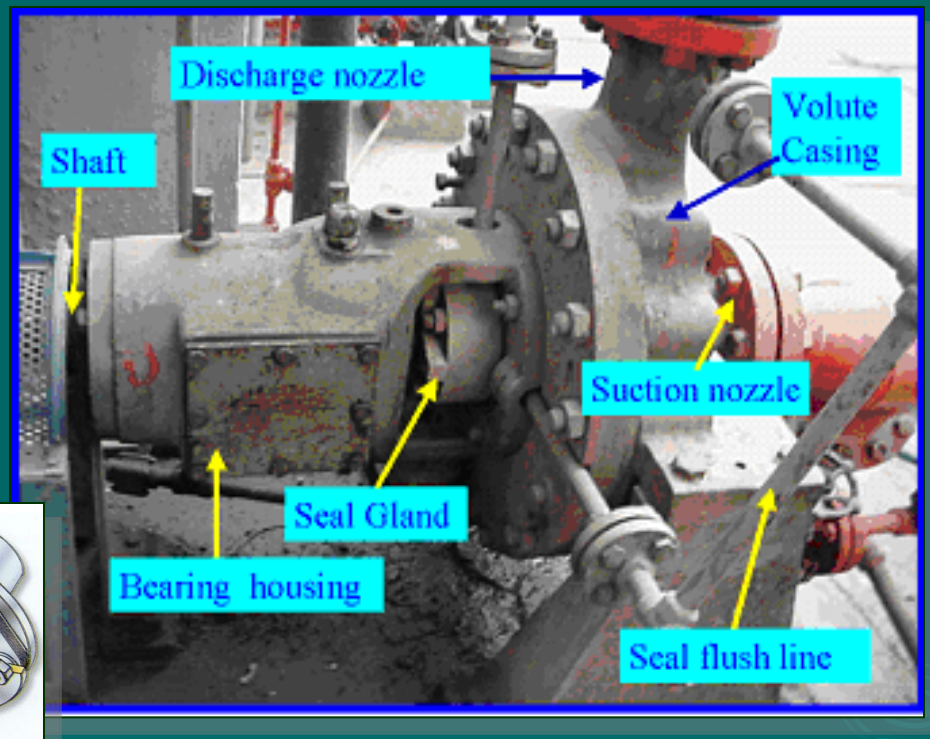
CENTRIFUGAL PUMPS EXTERNAL COMPONENTS







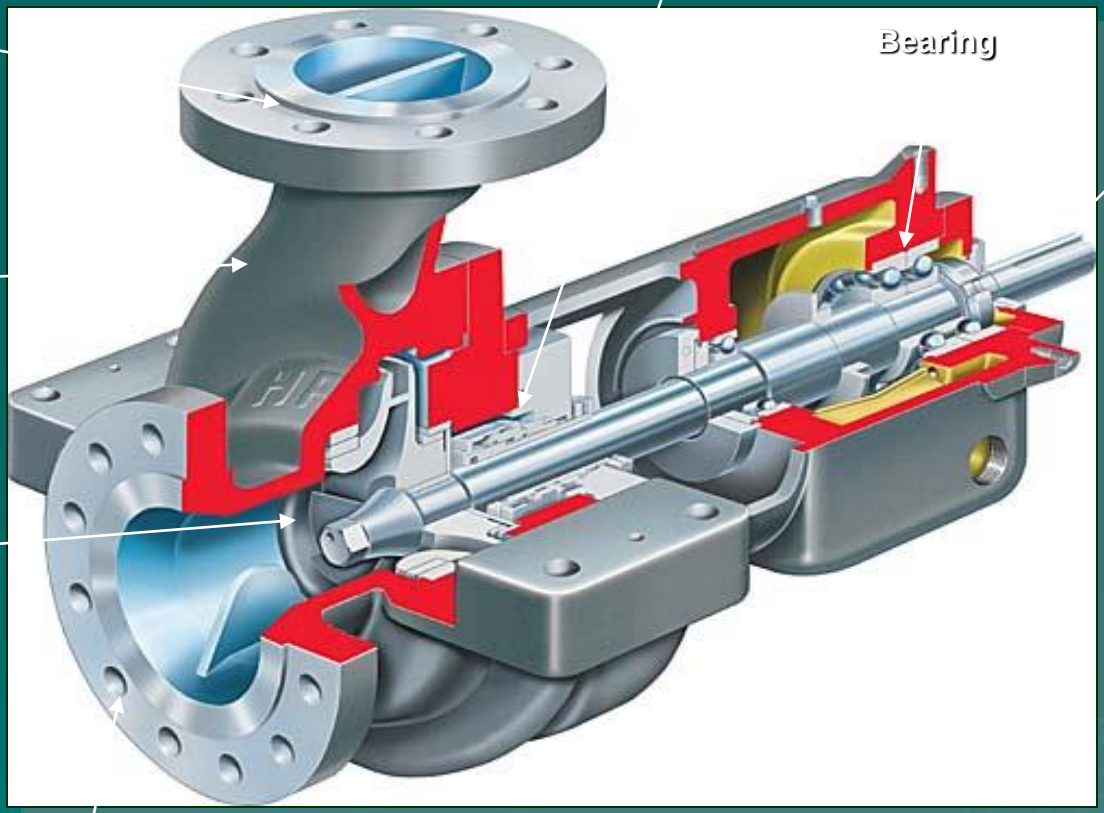
FLIXABLE COUPLING



EXTERNAL COMPONENTS OF
PUMP

Enppi

CENTRIFUGAL PUMPS INTERNAL COMPONENTS



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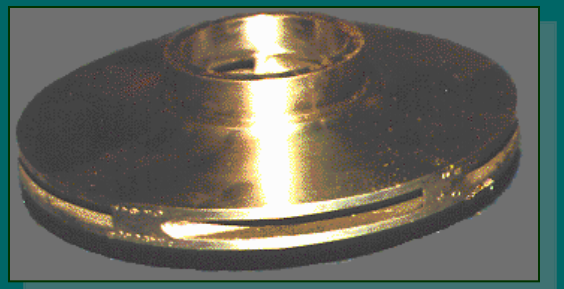
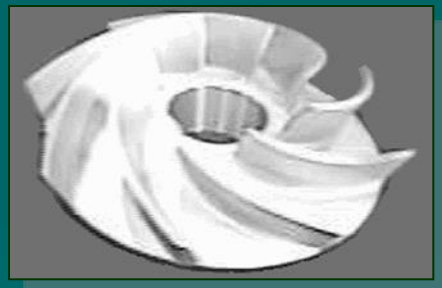
CENTRIFUGAL PUMPS INTERNAL COMPONENTS CONT'D

Different Types Of Impellers



CLOSED IMPELLER



SEMI-OPEN IMPELLER

OPEN IMPELLER

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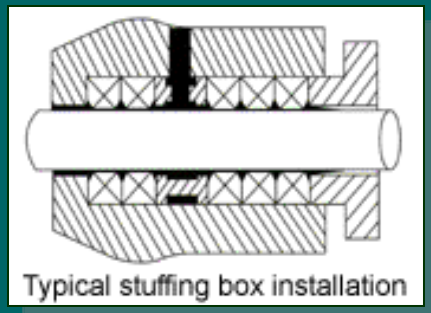
CENTRIFUGAL PUMPS INTERNAL COMPONENTS CONT'D

Leakage along pump shaft cane be minimized by ***Packing*** and ***Mechanical Seal***.

Packing is used to minimize leakage along the shaft by filling the stuffing box but it can't prevent leakage by 100%.

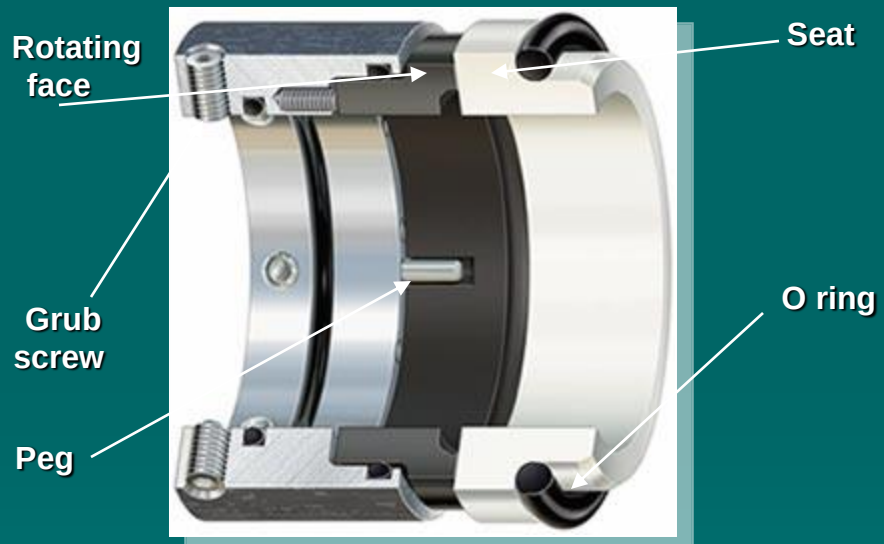


Typical stuffing box installation

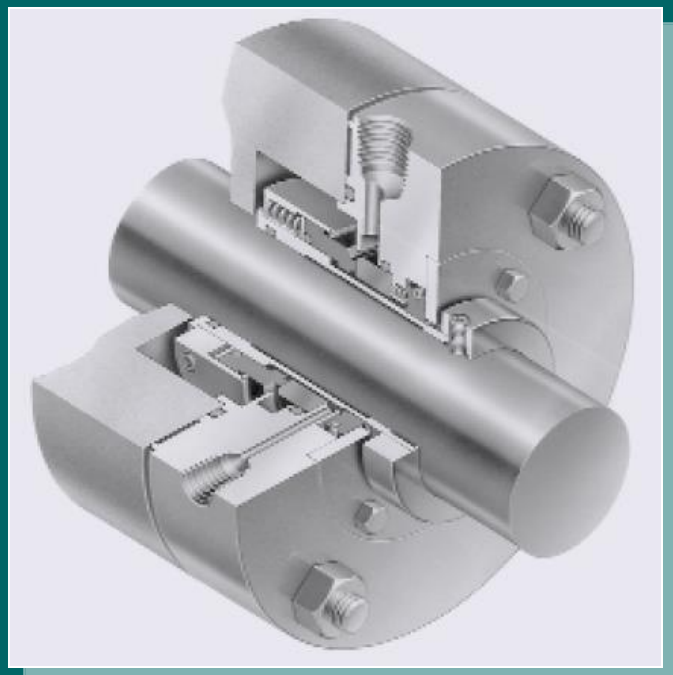
Packing on shaft sleeve

Lantern ring

Mechanical Seal is used when NO leakage is required specially in hazard cases mechanical seal shall be used.



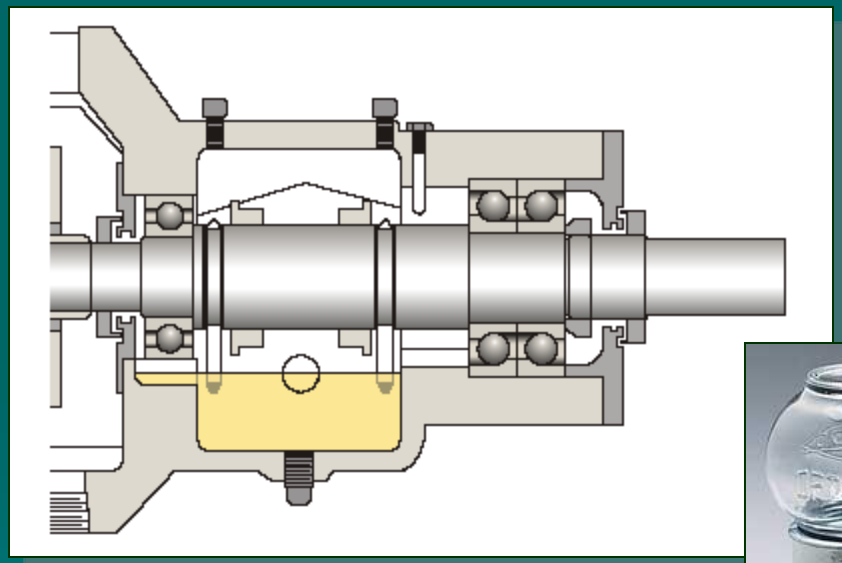
Cross section view of mechanical seal



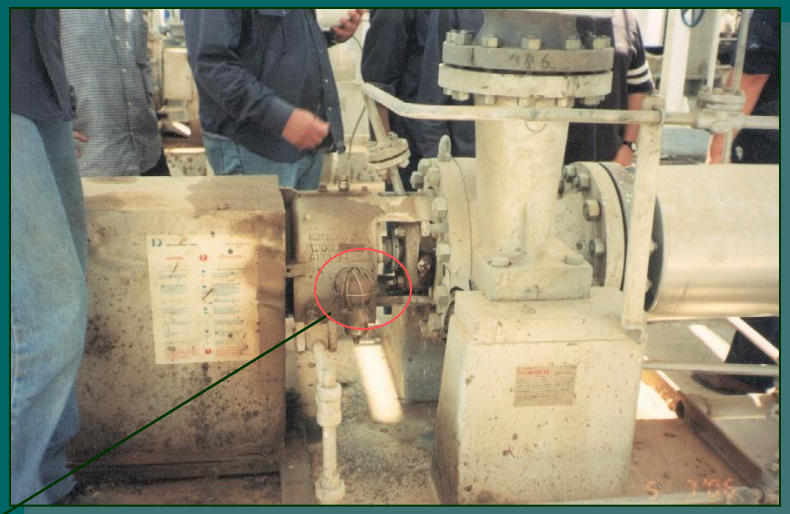
Enppi

CENTRIFUGAL PUMPS BEARING LUBRICATION

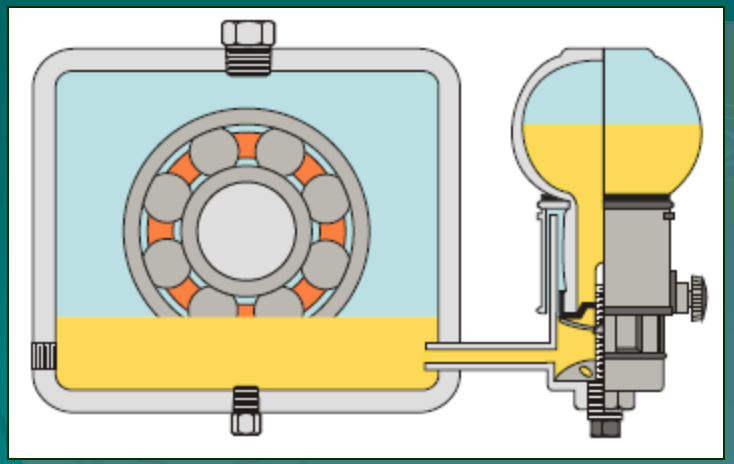
Proper ***Bearing lubrication*** is important to prevent overheat, rust and corrosion



OIL RING LUBRICATION



CONSTANT LEVEL OILER



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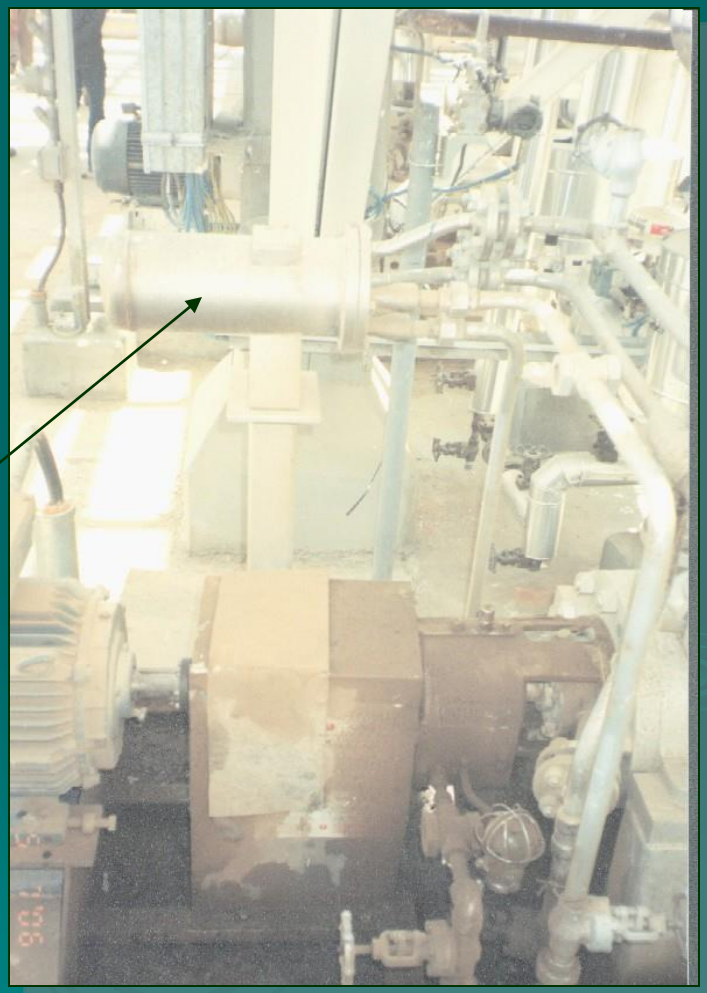
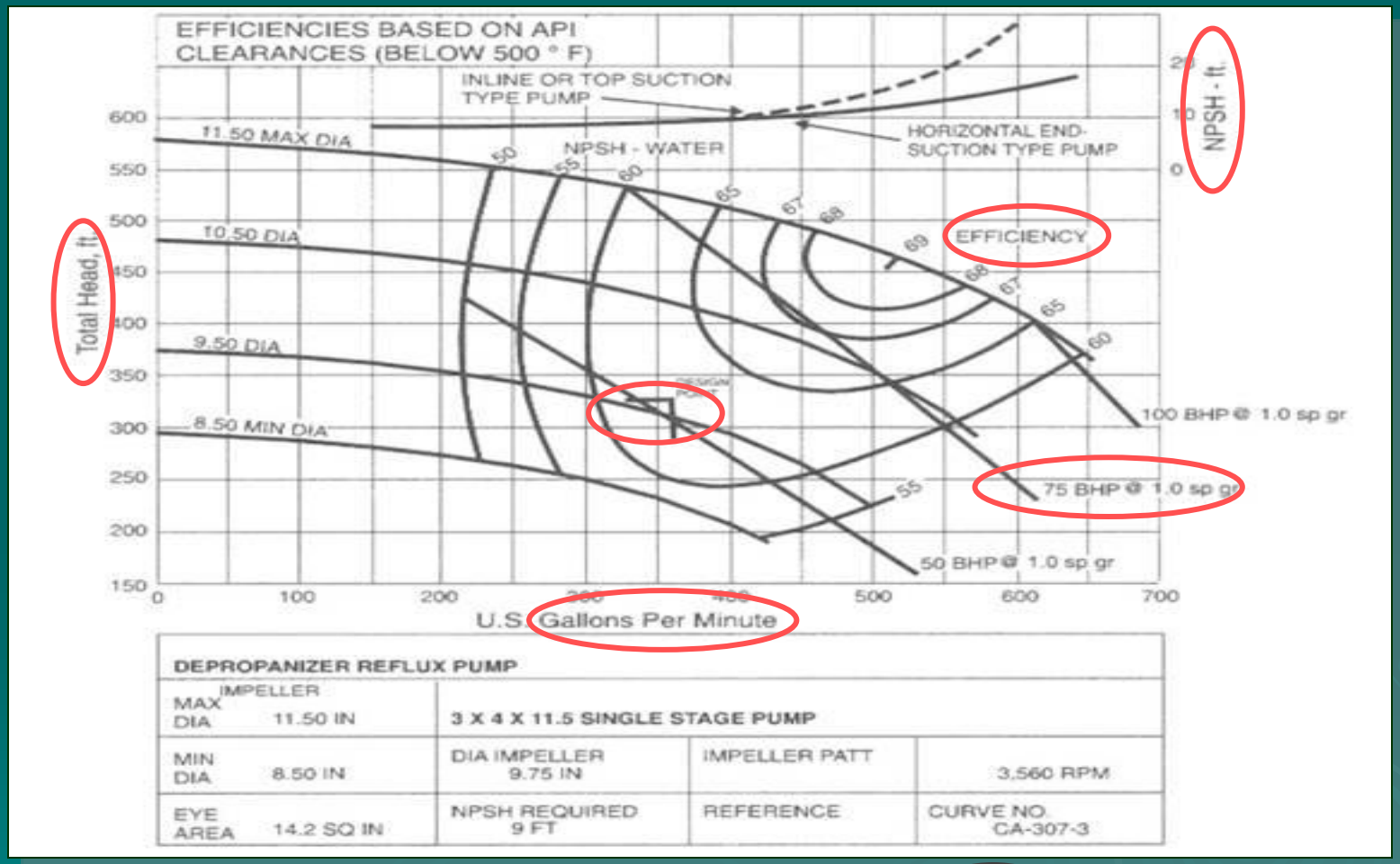
CENTRIFUGAL PUMPS STUFFING BOX & BEARING HOUSING COOLING

Heat generation is a problem in centrifugal pump particularly in pumps moving high temperature fluids, excessive heat is most damaging at bearing locations, water jackets are used here.



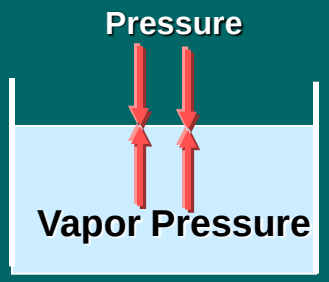
CENTRIFUGAL PUMPS PERFORMANCE CURVES



DEPROPANIZER REFLUX PUMP			
MAX IMPELLER DIA 11.50 IN	3 X 4 X 11.5 SINGLE STAGE PUMP		
MIN DIA 8.50 IN	DIA IMPELLER 9.75 IN	IMPELLER PATT	3,560 RPM
EYE AREA 14.2 SQ IN	NPSH REQUIRED 9 FT	REFERENCE	CURVE NO. CA-307-3

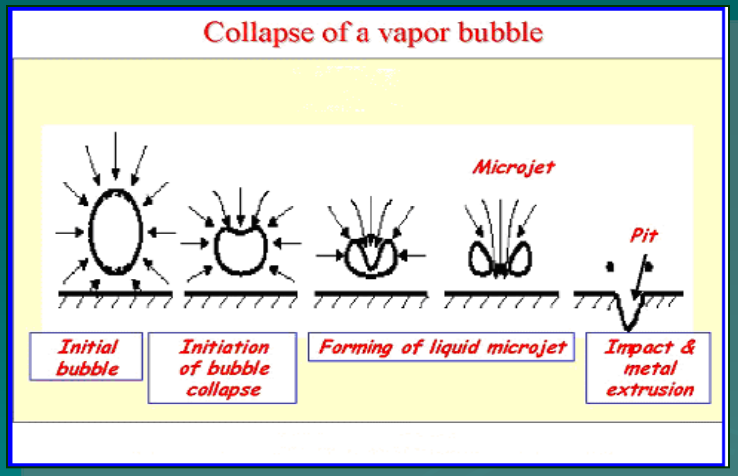
Enppi

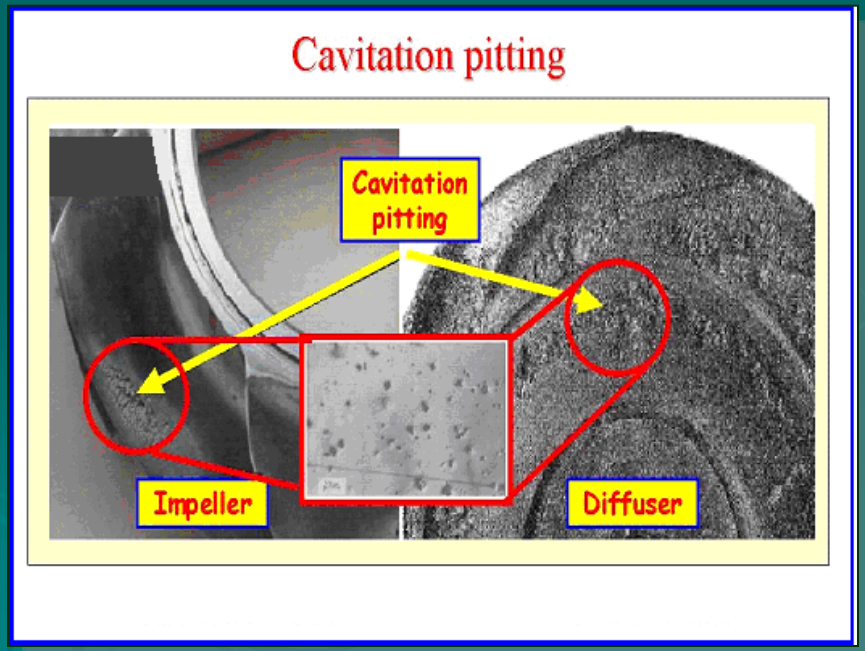
VAPOR PRESSURE, CAPITATION & NPSH



Vapor pressure is the pressure required to keep a liquid in the liquid state.

Cavitation occurs when a fluid's operational pressure drops below it's vapor pressure causing gas pockets and bubbles to form and collapse.





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NPSH stands for Net Positive Suction Head, and reflects the energy left in a fluid when the fluid is captured by the impeller and flung out to the casing. There are two expressions for NPSH: $NPSH_{Available}$ and $NPSH_{Required}$

$NPSH_{Available}$ is a function of the system in which the pump operates.

$$NPSH_{avail} = hs - h_{vpa} + h_{st} - h_{fs}$$

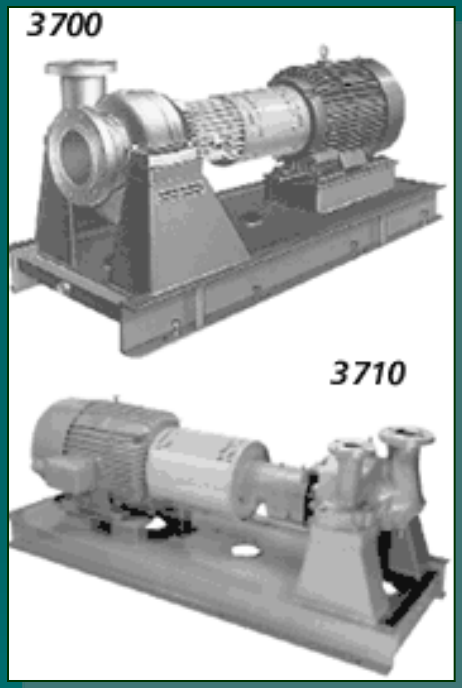
$NPSH_{Required}$ is a function of the pump design.

CENTRIFUGAL PUMPS CLASSIFICATION

Centrifugal pumps can be classified according to:-

- Shaft Position
- Bearing Position
- Type of Impeller
- Number of Impellers
- Volute Design
- Fluid Flow

Shaft Position



Horizontal pump

Vertical turbine pump

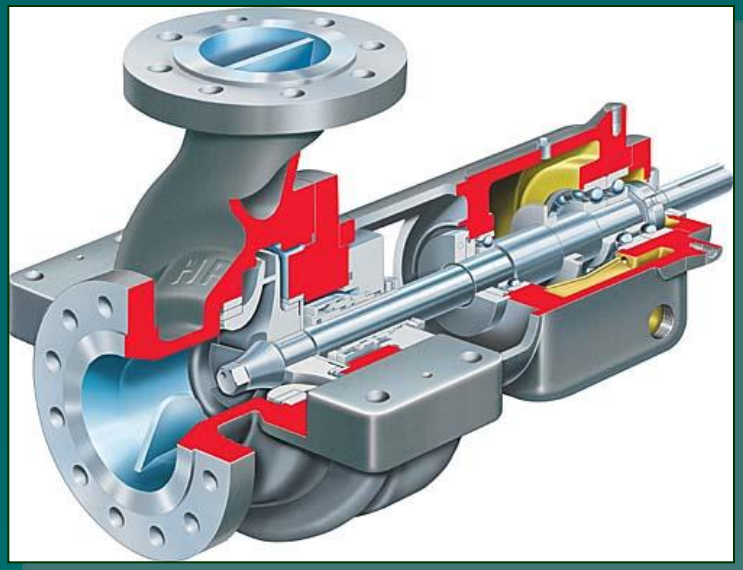
Sump pump

Vertical in-line pump

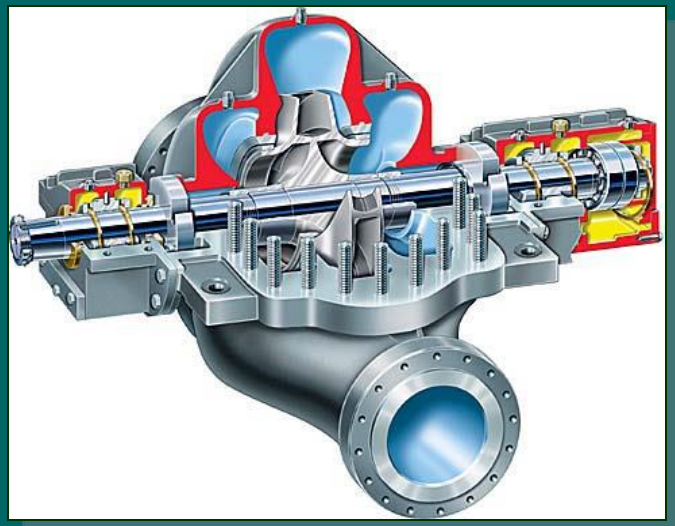
Vertical pumps

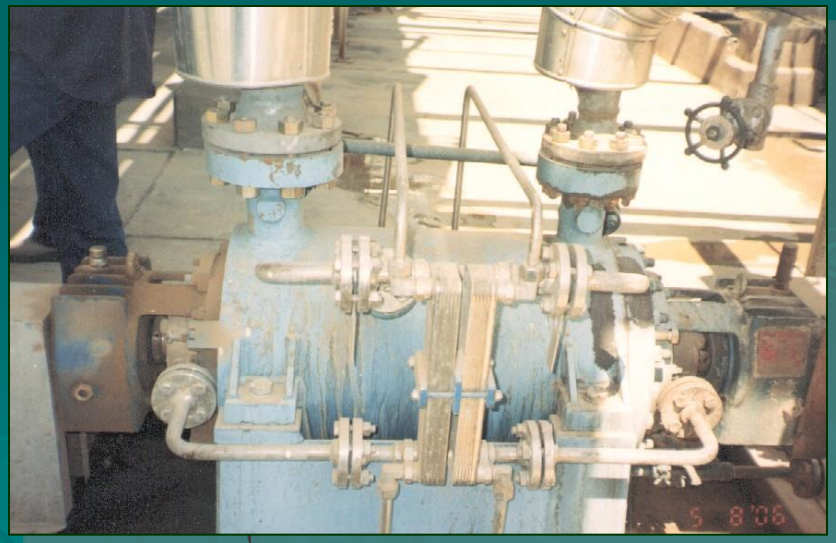
Enppi

Bearing Position



Overhung pump

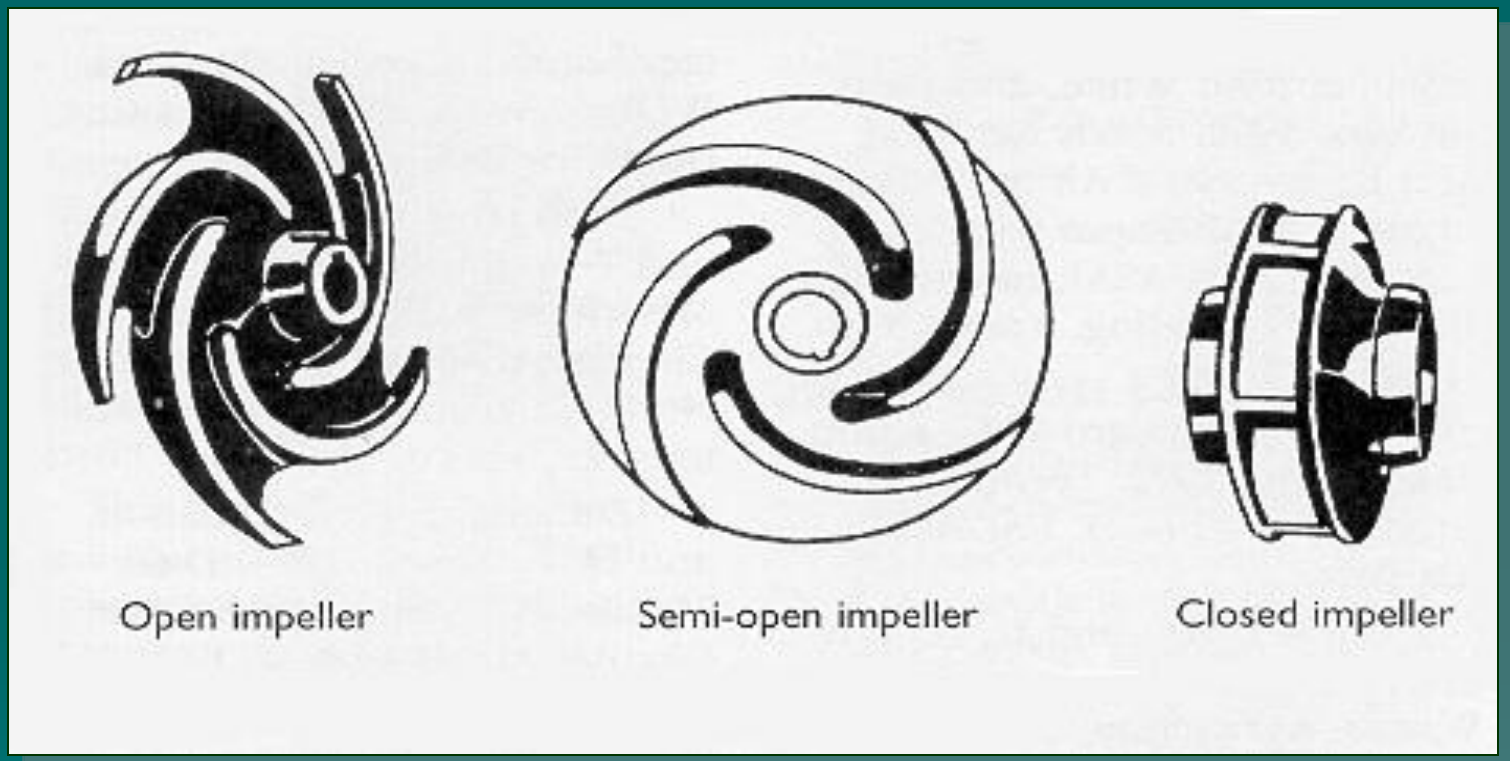




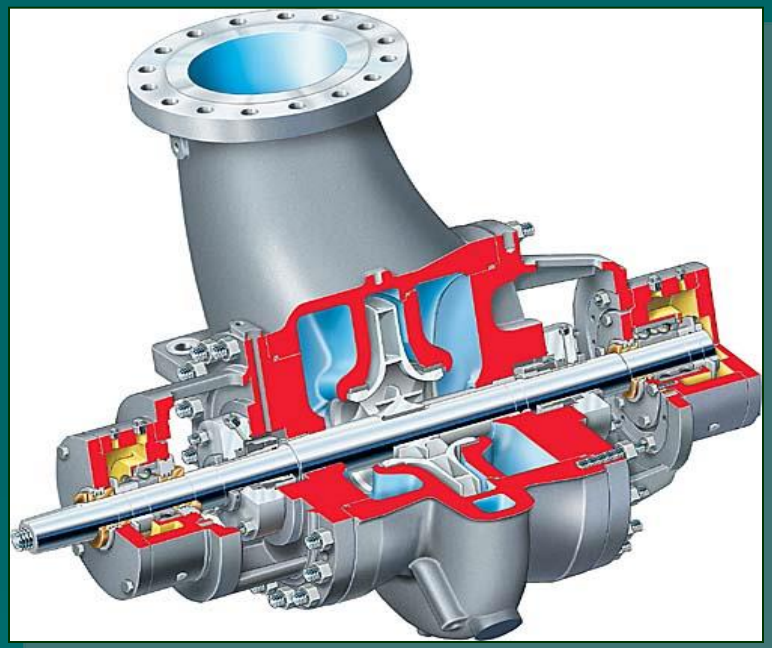
Between bearing pump

Enppi

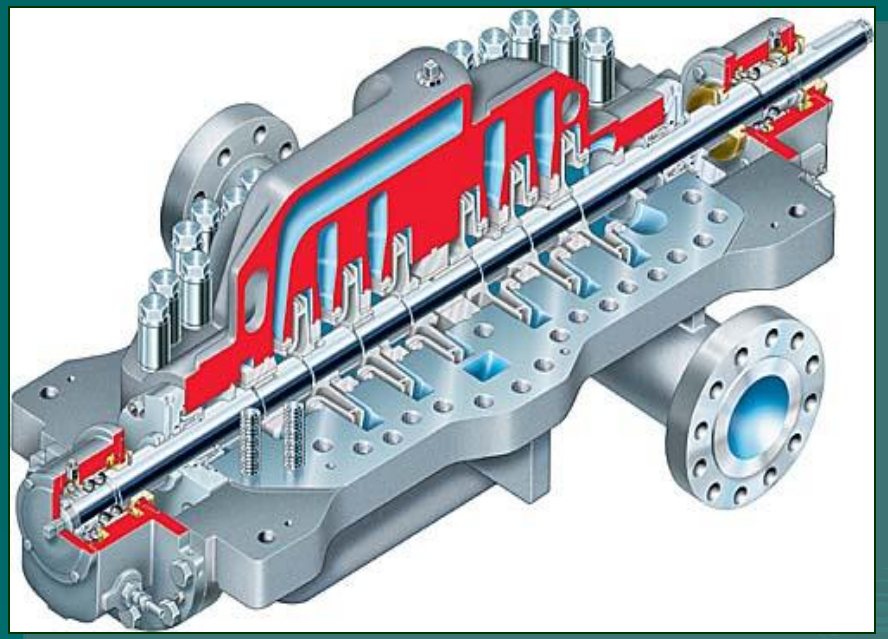
Type Of Impeller



Number Of Impellers



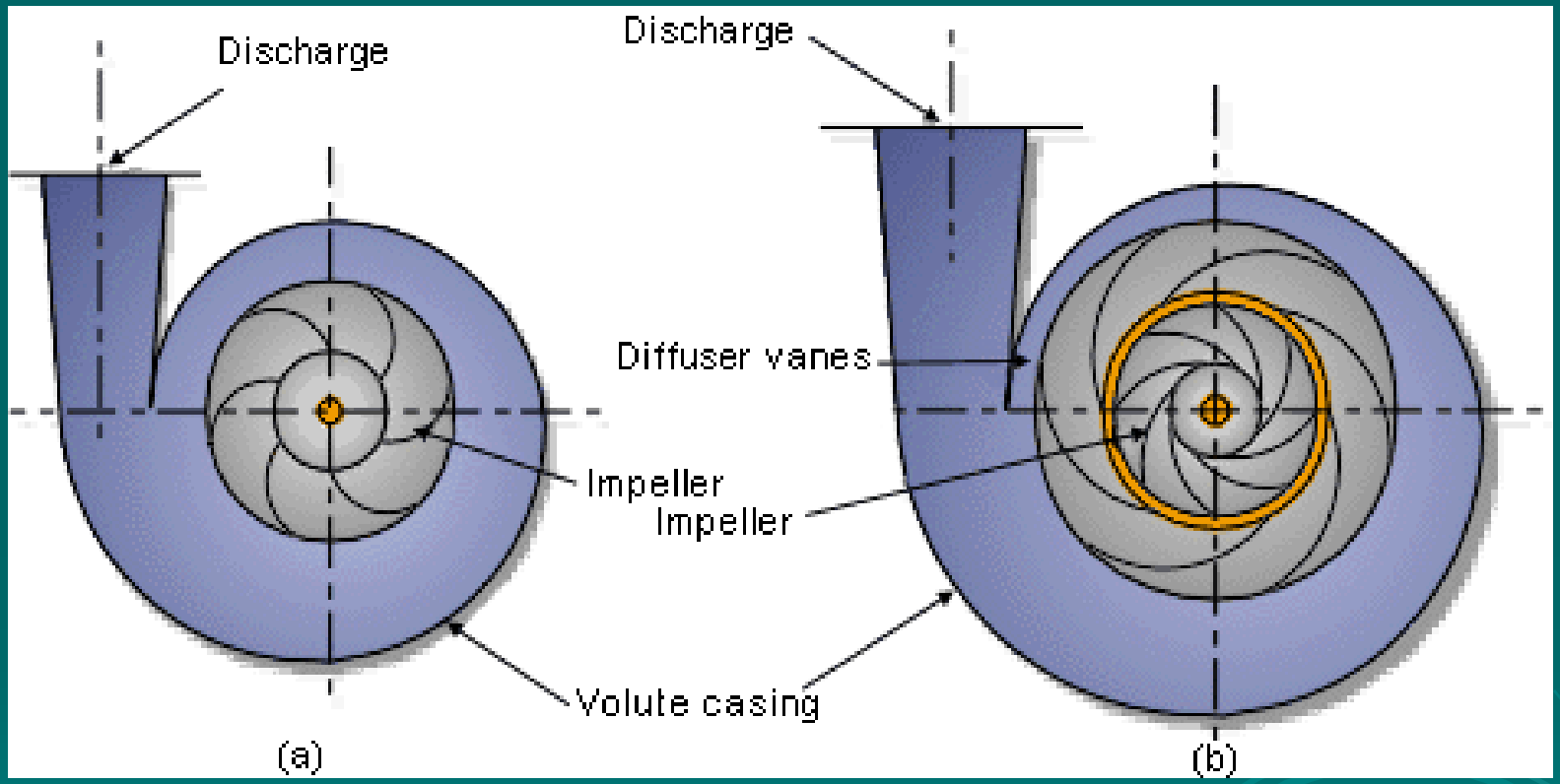
Single stage pump



Multi stage pump

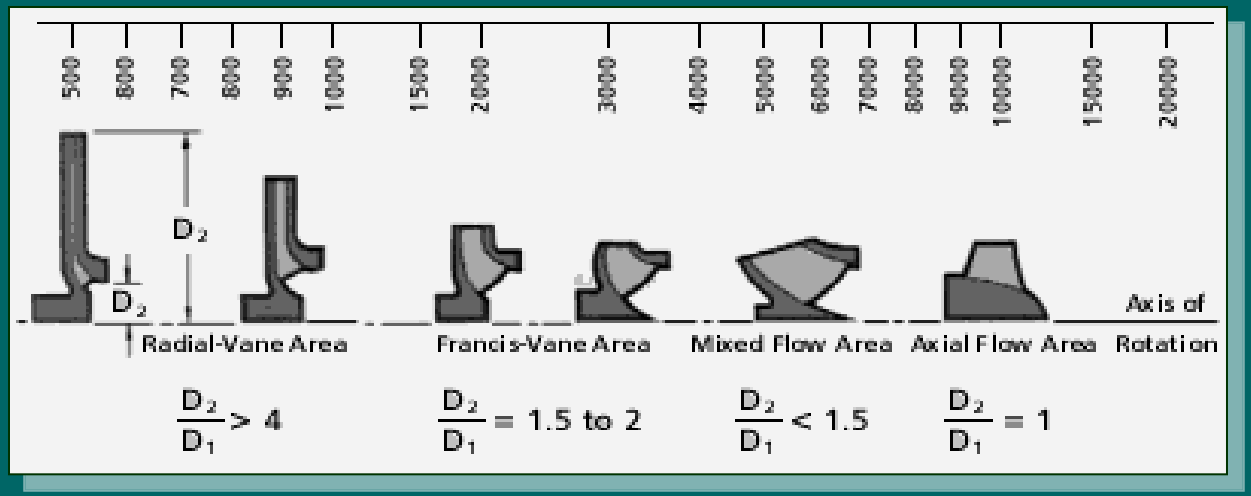
Enppi

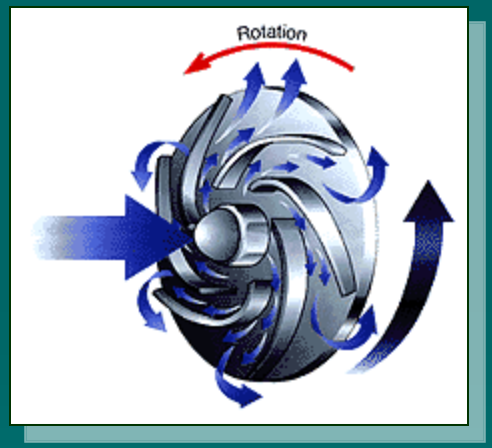
Volute Design



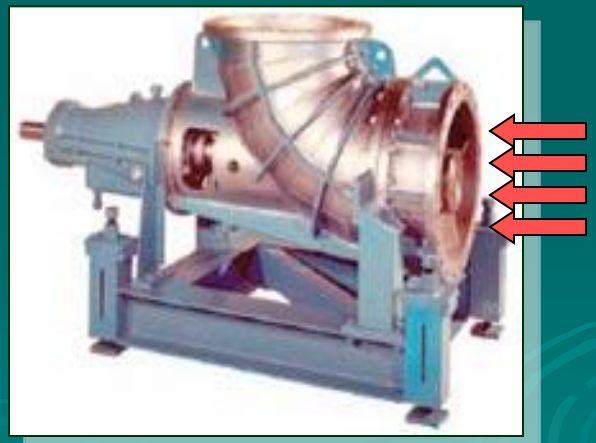
Enppi

Fluid Flow





Radial Flow



Axial Flow Pump

Enppi

Enppi

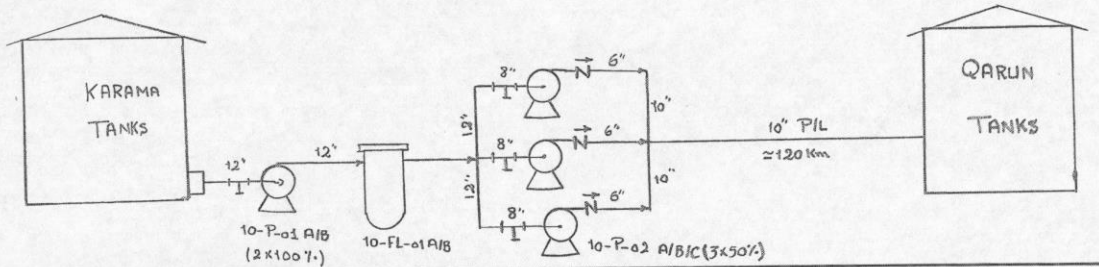
PUMP DATA

1	FLUID VAPOUR PRESSURE	Kg/cm^2a	0.32		
2	FLOW RATE	m^3/hr	132.7	10.0	% =K
3	RATED FLOW	m^3/hr	146.0		
4	ORIGINAL PRESSURE	Kg/cm^2a	1.00		
5	STATIC SUCTION HEAD	Kg/cm^2	0.000	0.00	m
6	SUCTION LINE FRICTION LOSS	Kg/cm^2	0.35		
7	PUMP SUCTION PRESSURE	Kg/cm^2a	0.650		
8	NPSHA	m	4.06		
9	NPSHR	m			
10	PRESSURE AT DELIVERY	Kg/cm^2a	4.00		
11	STATIC DISCHARGE HEAD	Kg/cm^2	0.02	0.30	m
12	DISCH. LINE FRICTION LOSS	Kg/cm^2	0.15		
13	EXCHANGER PRESS. DROP	Kg/cm^2	0.00		
14	FILTER PRESS. DROP	Kg/cm^2	1.00		
15	FLOW ELEMENT PRESS. DROP	Kg/cm^2	0.00		
16	METERING STATION PRESS DROP	Kg/cm^2	0.00		
17	CONTROL VALVE PRESS. DROP	Kg/cm^2	0.00	% DYN LOSS	
18	CONTINGENCY	Kg/cm^2	0.09	2 % DIF LOSS	
19	PUMP DISCHARGE PRESSURE	Kg/cm^2a	5.3		
20	PUMP DIFFRENTIAL PRESSURE	Kg/cm^2	4.6		
21	PUMP DIFFRENTIAL HEAD	m	56		
22	MAX. SUCTION PRESSURE	Kg/cm^2a	3.00		
23	MAX. DIFFRENTIAL PRESSURE	Kg/cm^2	5.54	20 % OVERDESIGN	
24	MAX. DISCHARGE PRESSURE	Kg/cm^2a	8.08		
25	MIN. FLOW	m^3/hr	33.2	25% NOR. FLOW	
26	VISCOSITY	cP	62.32	AT 20 °C 33.2	AT 30 °C
27	SPECIFIC GRAVITY AT O.T		0.82	AT 20 °C	
28	OPERATING TEMPERATURE	°C	20-30		

RECORD DATA

29	PUMP DISC DYN LOSS (NORMAL)		
30	PUMP-CV DYN LOSS (NORMAL)		
31	CV-DELV DYN LOSS (NORMAL)		
32	MAX. SUCTION LIQUED LEVEL	meter	

SYSTEM PROFILE



PRESSURE PROFILE

CONTROL VALVE DATA

33	CRITICAL PRESSURE (LIQ.)	Kg/cm^2a		38	MOL. WT. (GAS)				
34	VAPOUR PRESSURE (UPSTRM VLV)	Kg/cm^2a		39	DEG. OF SUPERHEAT (STEAM)	°C			
35	VISCOSITY | % FLASH (VOL)	CP		40	MAX. VALVE ^P	Kg/cm2			
36	SPECIFIC GRAVITY			41	VALVE ACTION ON AIR LOSS				
37	OPERATING TEMPERATURE	°C		42	LEAKAGE CLASS				

		DESIGN			START-UP/GENERATION				
		MIN. OPER. FLOW	NOR. OPER. FLOW	MAX. OPER. FLOW	MIN. OPER. FLOW	NOR. OPER. FLOW	MIN. OPER. FLOW	NOR. OPER. FLOW	MAX. OPER. FLOW
43	INLET PRESSURE (Kg/cm^2a)								
44	OUTLET PRESSURE (Kg/cm^2a)								
45	DEFFRENTIAL PRESSURE (Kg/cm^2)								
46	VOLUMETRIC FLOW (m^3/hr)								
47	CALCULATED VALVE CV								
48									
49									

NOTES

NOTES

1) One booster pump in operation + one pump stand-by (2 X 100 %)
2) The flow rate above is per individual pump as per Mechinary Department Request.
3) The vapor pressure above was provided by QARUN.

REV	DATE	DESCRIPTION	BY	CHKD	DESD	APPROVED
1	June 16, 04	ISSUED FOR APPROVAL				
0	April 13,04	ISSUED FOR COST ESTIMATE	SIGNATURE ON RECORD			

PUMP AND CONTROL VALVE DESIGN SHEET

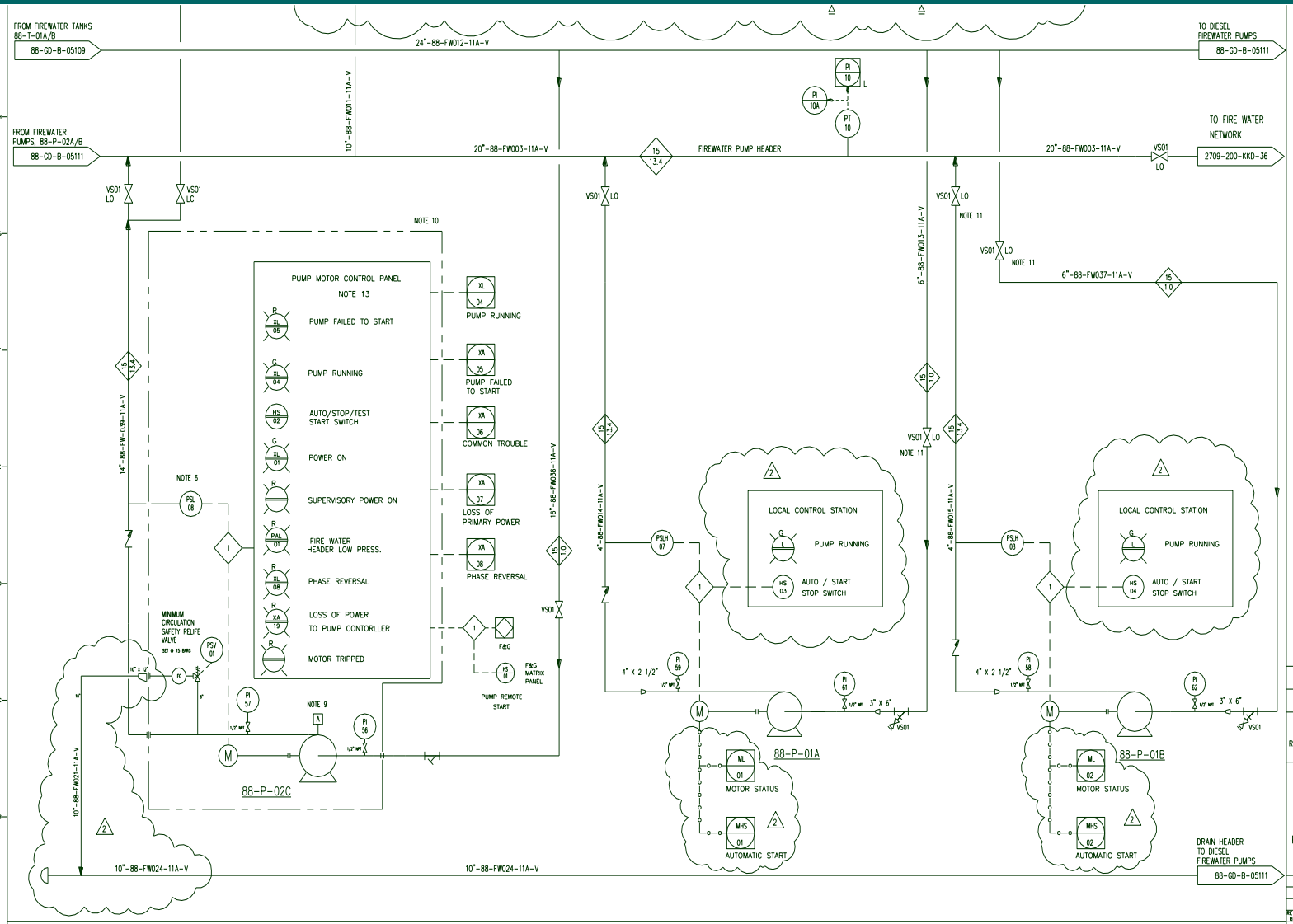
DESIGN SHEET

JOB	7532-497	P & ID No: 7532-497-KKD-01	SHEET 0F
PROJECT:	DETAILED ENGINEERING FOR KARAMA - QARUN PIPELINE		
PROJ No:	7532-497		

ENGINEERING FOR THE PETROLEUM AND PROCESS INDUSTRIES

PUMP:	NEW	CONTROL VALVE :	REV.
SERVICE:	BOOSTER CRUDE OIL PUMP AND SPARE 10-P-01A/B		1

FORM NO. 0-EI-5582



9. AIR RELEASE AUTOMATIC
10. ALL ITEMS WITHIN THE BATTERY LIMIT OF FIRE WATER PUMP SHOULD E IN PUMP SUPPLIER SCOPE OF SUPPLY
11. DELETED
12. FLOW AND PRESSURE INDICATORS TO BE POSITIONED IN VIEW FROM TE
13. INCLUDED IN PUMP SUPPLIER SCOPE OF SUPPLY
14. AT LEAST (10 x D) STRAIGHT RUN UPSTREAM AND DOWNSTREAM THE

REV.	DATE	DESCRIPTION	HSE	HSE LEAD ENG.	PIPING
2	06/08/03	ISSUED FOR CONSTRUCTION			
1	7/7/02	TOTALLY REVISED & RE-ISSUED FOR DESGN			

PROJECT NO.
2709-200

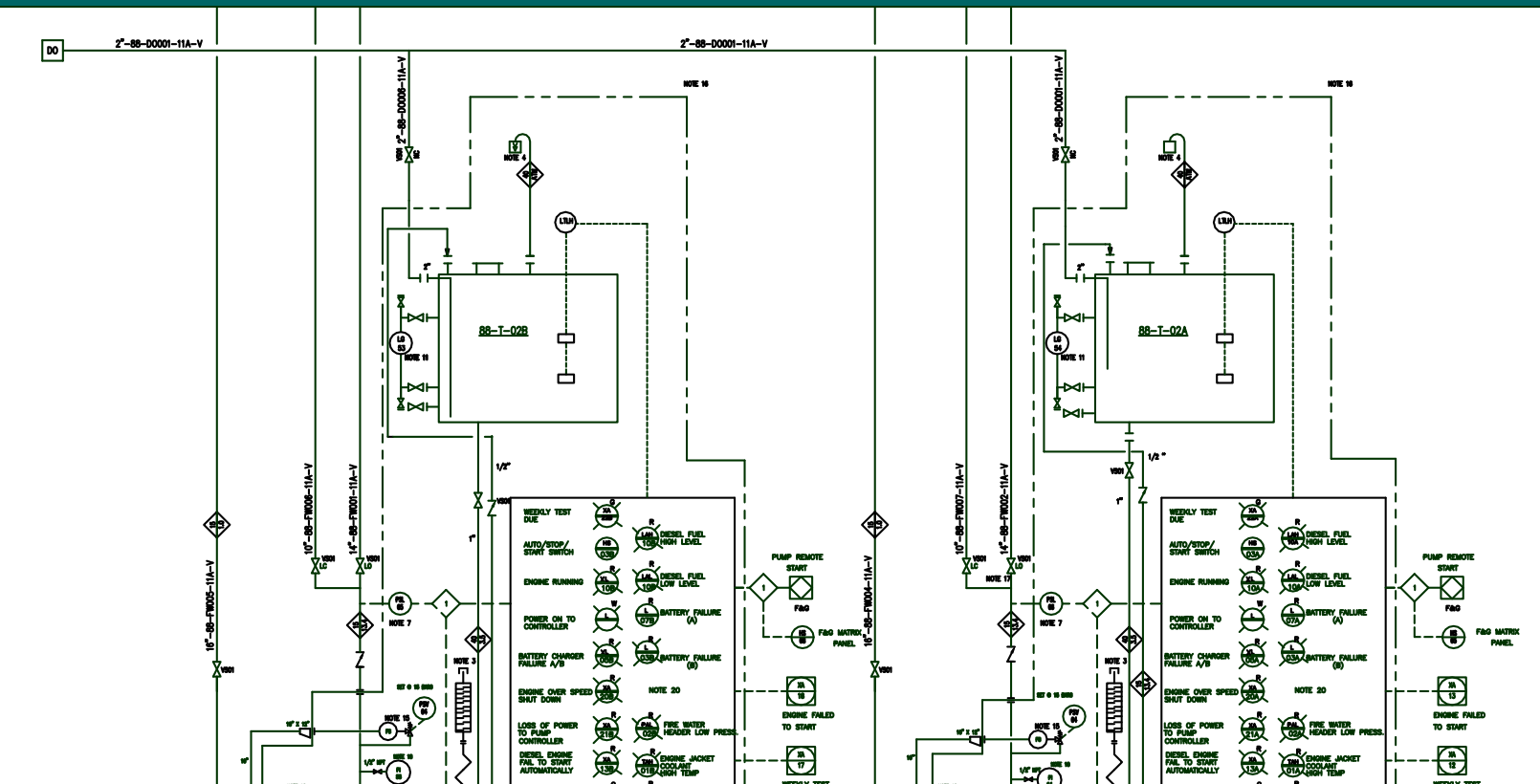
Enppi
ENGINEERING FOR THE PETROLEUM AND PROC

REVISIONE Revision	DATA Date	DESCRIZIONE - Description
0		ISSUED FOR DESIGN
A	25.10.01	ISSUE FOR COMMENT

UNITED GAS DERIVATIVES
PORT SAID - EGYPT

88-P-02C
FIRE WATER PUMP (ELECTRIC)
DES. CAPACITY = 1000 m3/h
DENSITY @ 15°C = 999 kg/m3

88-P-01A/B
FIREWATER JOCKEY PUMPS.
DES. CAPACITY = 50 m3/h
DENSITY @ 15°C = 999 kg/m3



10. DIESEL DAY TANK LEVEL SWITCH LOW LOW SHALL INITIAT FUEL REMAINS.
11. DIESEL DAY TANK LEVEL GAUGE TO BE READABLE FROM
12. DIESEL DAY TANK LEVEL SWITCH LOW SHALL INITIATE LO REMAINS.
13. DIESEL DAY TANKS TO BE PROVIDED BY PUMP VENDOR.
14. ALL EQUIPMENT & COMPONENT SHALL BE ACCORDING TO
15. DISCHARGE FROM PSV SHALL BE VISIBLE
16. ALL ITEMS WITHIN THE BATTERY LIMIT OF FIRE WATER PU IN PUMP SUPPLIER SCOPE OF SUPPLY
17. DELETED
18. PRESSURE GAUGE ARE INSTALLED ON PUMP FLANGE.
19. PRESSURE SWITCH LOW SETTING 4.5 BARG.
20. ALL INDICATION LAMPS ARE PUSH TO TEST.
21. ALL PUMPS AND ACCESSORIES ARE SUPPLIED LOOSE, NO

REV.	DATE	DESCRIPTION
2	06/08/03	ISSUED FOR CONSTRUCTION
1	7/7/02	TOTALLY REVISED & RE-ISSUED FOR DESIGN

PROJECT NO.
2709-200

Enppi
ENGINEERING FOR THE PETROL

REVISION	DATE	DESCRIPTION
0		ISSUED FOR DESIGN
A	25.10.01	ISSUE FOR COMMENT

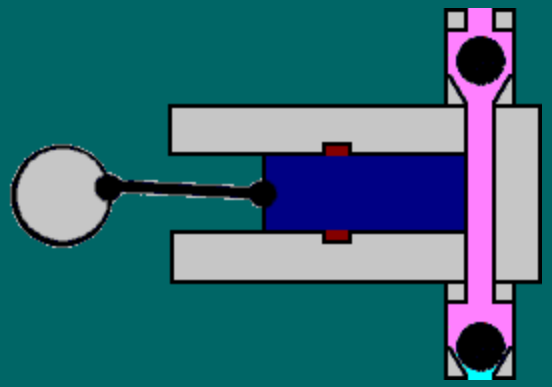
POSITIVE DISPLACEMENT PUMPS

Positive displacement pumps are used for:-

- Low volume applications.
- High pressures are required to move fluids.

POSITIVE DISPLACEMENT PUMPS OPERATING PRINCIPAL

A positive displacement pump has an expanding cavity on the suction side of the pump and a decreasing cavity on the discharge side.

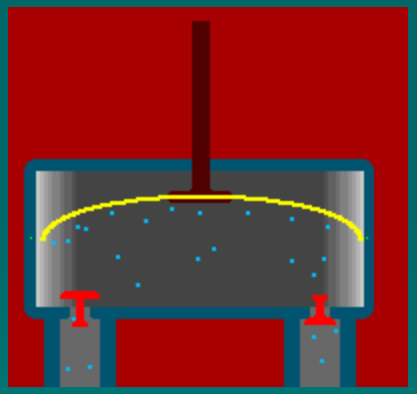


Liquid is allowed to flow into the pump as the cavity on the suction side expands and the liquid is forced out of the discharge as the cavity collapses.

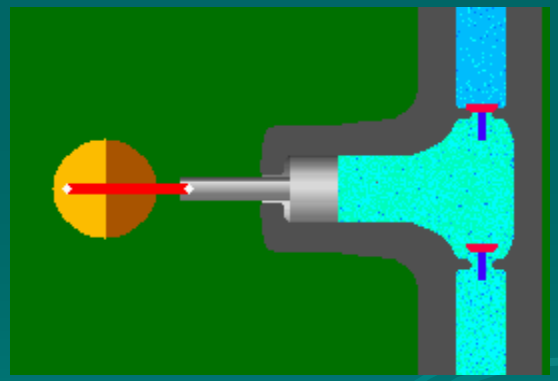
RECIPROCATING PUMPS

Reciprocating pumps types are :-

- **Piston Pumps**
- **Plunger Pumps**
- **Diaphragm Pumps**



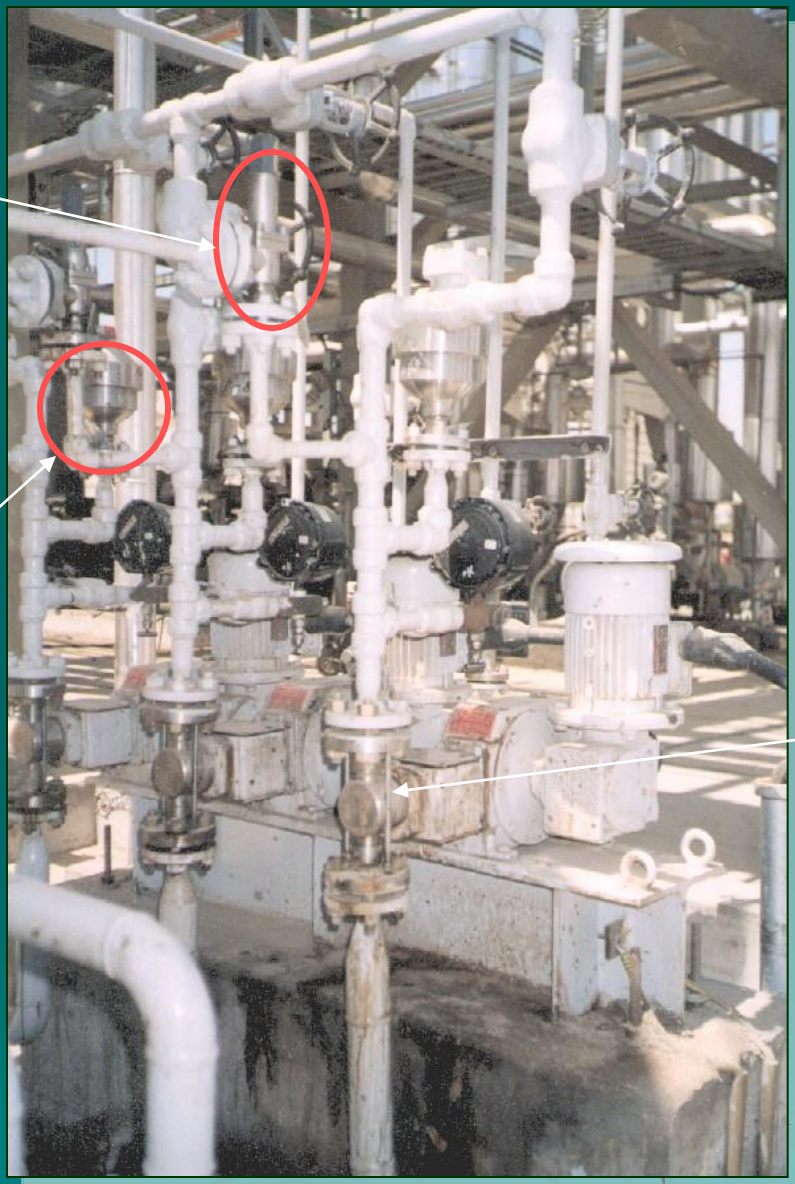
Diaphragm pump



Piston pump

Safety relief valve

Pulsation dampener



Plunger pump

Chemical injection pumps

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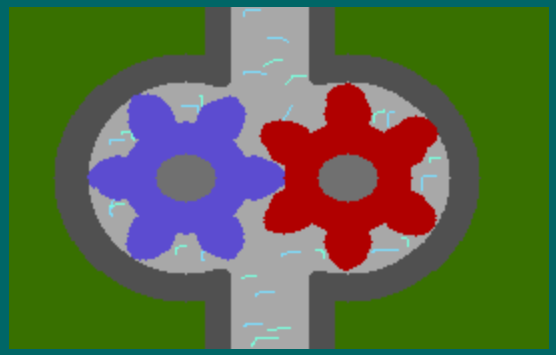
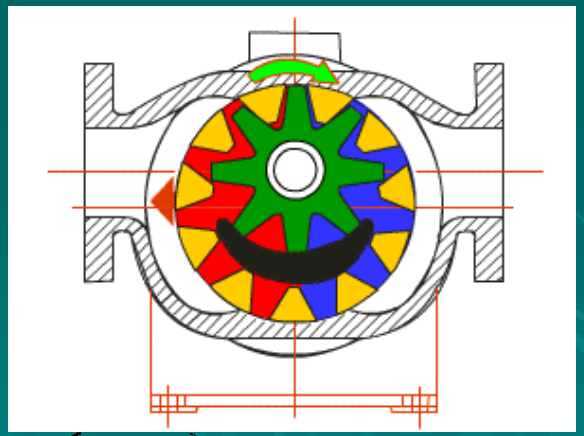
Rotary Pumps

External gear pump **-** Fluid is carried between gear teeth and is expelled by the meshing of the gears which cooperate to provide continuous sealing between the pump inlet and outlet.



External gear pump

Internal gear pump **-** The outer gear (rotor) drives the inner or idler gear on a stationary pin. The gears create voids as they come out of mesh and liquid flows into the cavities. As the gears come back into mesh, the volume is reduced and the liquid is forced.



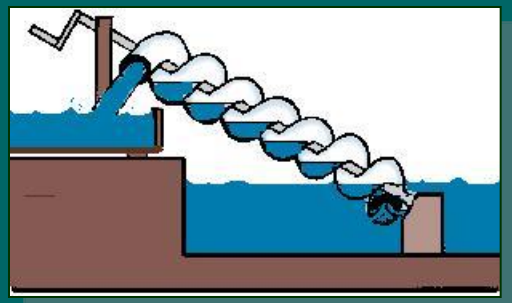
Internal gear pumps

Screw pumps

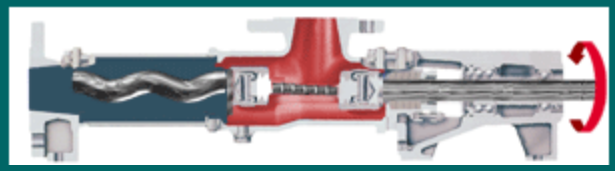
Screw pumps carry fluid in the spaces between the screw threads. The fluid is displaced axially as the screws mesh.

Single screw pumps - are commonly called progressive cavity pumps. They have a rotor with external threads and a stator with internal threads. The rotor threads are eccentric to the axis of rotation.

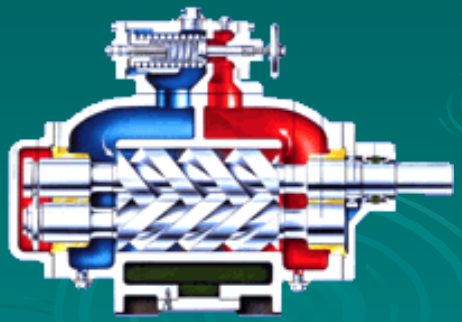
Multiple screw pumps - have multiple external screw threads. These pumps may be timed or un-timed



Archimedes Screw



Progressive cavity pump



Screw pump

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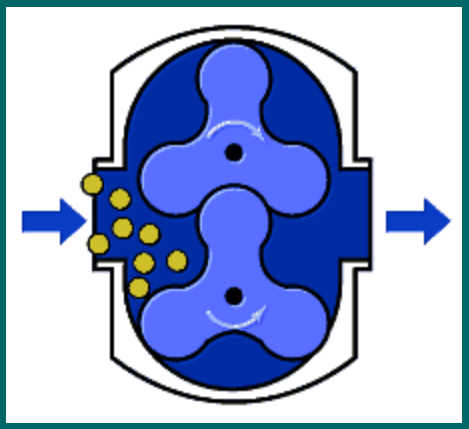
Lobe pumps

Fluid is carried between rotor lobes which cooperate to provide continuous sealing between the pump inlet and outlet.

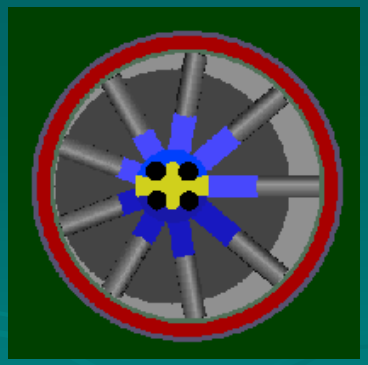


Lobe pump

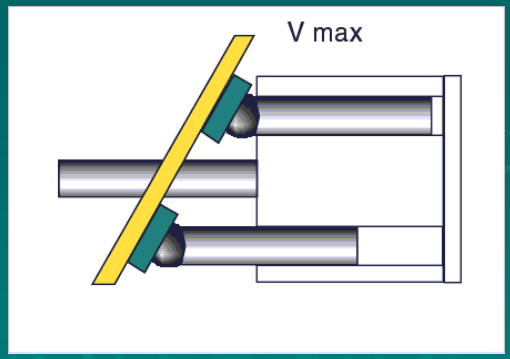
Piston pumps

Axial piston pump - depends on beveled “wobble” plate or equivalent off-center linkage system to reciprocating pistons.

Radial piston pump – depends on eccentric stator (or rotor) to give reciprocating action.



Radial piston pump



Axial piston pump

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