AIRTECH®
VACUUM

Installation, Operation and Maintenance Manual

3AV 1 to 3AV 430

3AV Close-Coupled Liquid Ring Pump
Installation, Operation, and Maintenance Manual

Table of Contents

1 General

The descriptions and instructions in these operating instructions refer to the standard pump versions.These operating instructions do not cover all possible design details nor variants. Any illustrations and specifications in these instructions are subject to technical modifications.

Note: Opening up the pump invalidates any warranty claim.

1.1 Application Fields

Airtech liquid ring vacuum pumps can be used for all gases, if the material chosen is chemically resistant both against the gas and the ring liquid. The pumps will work efficiently up to 33 mbar with water as the ring liquid at an inlet temperature of 15° C. When using different operating liquids, the characteristic curves will change (e.g. different physical properties of the gas or the operating liquid, any other additional liquid added, or delivery of gas-steam mixtures).

Service value limits see chapter 10.

1.2 Performance Data

Besides the operating data, the name plate of the pump shows the pump type, pump size and pump number, which have to be specified for any queries, supplementary orders and especially for spare-part orders.

If you have any queries, please contact your supplier or the manufacturer.

2 Safety

These operating instructions contain basic information that must be considered at set-up and during operation and maintenance. For this reason, the commissioning engineer must read the operating instructions before assembly and commissioning. The manual must also be available to the responsible personnel/machine user at the pump's place of operation at all times.

In addition to the safety information included in this section, there is additional safety information throughout the manual; please read it carefully.

2.1 Imporatnt safety information in the Operating Instructions

This manual contains safety warnings regarding possible hazards to personnel. This information is marked by the symbol shown below:

(Safety sign according to DIN 4844-W8)

Warnings about electrical voltages are marked specifically by the sign below:

(Safety sign according to DIN 4844-W9)

Safety information which, if ignored, can result in danger to the pump and its functions are shown by the word

CAUTION

Information located directly on the pump, e.g.

- the arrow showing the direction of rotation
- the markings of the pipe connections

must always be observed and kept legible.

2.2 Qualification and Training of Personnel

The operating, maintenance and assembly personnel must be appropriately qualified for the work they carry out. The client must precisely outline the area of responsibility of the personnel, and monitor their duties.

If said personnel are not suitably qualified, they must be trained and instructed. If necessary, the manufacturer/supplier can carry out training courses on behalf of the operator of the pump. The operator must also ensure that all personnel have read and fully understood these operating instructions.

2.3 Risks Resulting from Ignoring the Safety Information

Ignoring the safety information may lead to hazards for the people involved as well as endangering the environment and the pump.

The non-observation of the safety information shall invalidate all claims for damages incl. compensation for damages.

In individual cases, the following dangers, **for example**, may result from ignoring safety information:

- Failure of important pump/system functions.
- Failure of specified maintenance and corrective maintenance methods.
- Endangering persons by electrical, mechanical and chemical reactions.
- Endangering the environment by leakage of dangerous materials.

2.4 Safety Conscious Working

Observe the safety information listed in these operating instructions, in addition to existing national accident prevention legislation as well as any internal working, operating and safety regulations applicable in the operator's plant.

2.5 Safety Information for the Operator/User

- If excessively hot or cold parts of the pump are exposed, the customer must install guards to ensure that these parts cannot be touched.
- Guards for moving parts (e.g. coupling) may not be removed while the pump is running.
- Leakages (e.g. from the shaft sealing) of dangerous material (e. g. explosive, poisonous or hot) must be discharged without causing any danger for persons or the environment. Legal regulations have to be observed.
- Dangers resulting from electrical energy must be excluded.

2.6 Safety Information for Maintenance, Inspection and Assembly Work

The operator must ensure that all maintenance, inspection and assembly work is carried out by authorized and qualified specialists, who are adequately informed having thoroughly read these operating instructions.

- The pump must be shut down completely before any work can be done on the unit. The procedure for shutting down the pump described in the operating instructions must always be observed.
- Pump units which deliver media hazardous to health, must be decontaminated.
- Directly after completion of work, all safety equipment and guards must be refitted or reactivated.
- Follow all instructions in the section on Comissioning (Section 6.2) before restarting the equipment.

2.7 Unauthorized Modification and Manufacture of Spare-Parts

Please consult the manufacturer before attempting to modify or alter the unit. Only spare parts and accessories authorized by the manufacturer should be used in the unit. Use of spare parts or accessories from other manufacturers will invalidate any warranty claims.

2.8 Unauthorized Operating Methods

The pump is only guaranteed to work properly if operated in accordance with the instructions in Section 1.1 of this manual. Airtech will not be responsible for any damages caused by improper operation of the pump.

The unit meets all current technical specifications and was manufactured according to standardized safety regulations (EN 292).

Failure to follow the instructions in this manual will invalidate any warranty claims.

3 Transportation and Storage

3.1 Transportation

The unit must be handled properly during transportation. For pumps with a base plate and motor, do not suspend the pump from the ring loop on the motor.

3.2 Storage

When not in use, The unit should be stored in a dry environment and covered to ensure that it is free of any dirt or debris.

4 Description of the Product

4.1 Construction

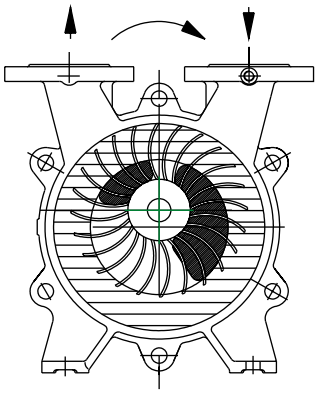
Airtech liquid ring vacuum pumps of the 3AV type are closed coupled pumps.
The motor also serves as a pump shaft.
The shaft sealing is effected by a single acting mechanical seal

The pump is of simple, robust construction.

4.2 Function

The liquid ring rotates inside the working area eccentrically to the shaft. The impeller transmits the drive performance by the circulating liquid ring as compression power to the gas to be delivered. This produces low pulsation compression.

Figure 1: *Function*



The service liquid - normally water - must be added and cooled continuously. This dissipates the resulting compression heat and adds liquid to the ring, since part of the liquid is continuously dissipated along with the gas on the pressure side. The liquid can be separated from the gas in a discharge separator attached.

5 Set up and Installation

CAUTION

Failure to observe all safety guidelines listed in this section will invalidate any warranty claims.

5.1 Installation Location

Always install the unit in an area where the pump is easily accessible.

5.2 Setting-up the Unit

The vacuum pump must be attached to a completely flat base plate. If low vibration running is desirable, the unit should be fixed to a vibration insulated foundation.

The mounting position must be horizontal. The suction and discharge fitting of the pump should be positioned vertically facing upward or horizontally to the right (view towards pump). The horizontal discharge connection is situated from the bottom. In order to keep the pump from draining out when not in use, the discharge pipe should be raised up to the middle of the shaft.

5.3 Pipes

The pump is supplied with suction and discharge connections for the operating liquid which are sealed to avoid contamination from any foreign substances. It is recommended that you do not remove the seals until the pipes are fitted.

The diameter of the suction, discharge and operating liquid pipes should be equal to the corresponding pump connections. For longer pipes, larger internal diameters should be considered.

Pump piping should be installed without strain. A flex connector should normally be provided for the suction and discharge.

Before starting the pump check the integrity of the piping carefully.

5.3.1 Suction Connection

A non-return valve must be mounted in the suction pipe in order to avoid it being filled with operating liquid and avoid a pressure drop in the vacuum system.

CAUTION

If an isolation valve is installed in the suction and if the pump is run when this shut-off device is closed, cavitation will occur. This will damage the pump during a longer working period.

5.3.2 Discharge Connections

If a shut off valve is installed in the discharge, care must be taken that the pump will not be operated or kept running when the discharge valve is closed.

5.4 Electrical connection

Electrical connection of the pump must be carried out by skilled personnel only!

The connecting diagram of the motors is shown inside the terminal box cover.

Apart from proper electrical installation (taking into account appropriate guidelines and regulations) check the pump's direction of rotation to ensure it matches the arrow on the pump casing.

Always install a magnetic motor starter to protect the pump motor.

Operating without a protective motor starter on the input side that is properly set (see name plate for currents) shall invalidate any claims for compensation of damages. The proper flow direction of the gas is marked by arrows on the pump casing.

CAUTION

In order to avoid damage to the mechanical seal, the pump must be operated in the proper direction of rotation.

5.5 Operation modes

5.5.1 Partial Recirculation

(standard operation under normal conditions)

The set-up is per *Figure 2a* (page 8) The operating liquid B consists of clean liquid F and circulating liquid U. Liquid leaves the liquid separator as discharge liquid *A* through the liquid discharge U_A. The pressure of clean liquid should exceed max. 0,2 bar the pressure at the pump discharge nozzle in the liquid separator.

5.5.2 Full Recirculation

Closed circulation cooling should be used for operating liquids that may be corrosive or hazardous or where highly combustible gases are delivered. The set-up is per *Fig. 3* (page 8). At connection U_A a shut-off device will be attached. The operating liquid *B* consists of circulation liquid U. In the circulating pipe I_U, a liquid pump P_B has to be mounted. If the vacuum pump is to run for more than 5 minutes without without sufficient pressure difference between suction and discharge.

The heat exchanger *W* should be sized to dissipate about 85% of the motor power and any possible heat or condensation. The heat exchanger *W* may be omitted if the vacuum pump will be run for a short period of time and if the liquid in the system cools down to ambient temperature during the period before it is restored.

5.5.3 Once-Through

Continuous cooling will occur if sufficient liquid is available that is not being recycled as operating liquid.

The unit is to be set-up according to *Figure 4a.* The connection U_U will be sealed. The operating liquid *B* consists of clean liquid *F.* The required pressure of clean liquid should not considerably exceed 0 bar (atmospheric pressure).

If the clean liquid pressure is fluctuating considerably (from time to time an over pressure of 0,2 bar will be exceeded), it is useful to provide a pressure-reducing valve R_{F3} (*Figure 2b*) or lead the clean liquid into a container *b* with float valve $R_{F1.}$ The pump primes the operating liquid *B* out of this container *(Figure 4b)*. The level of the liquid should be in the middle of the shaft.

In situations where the gas and the liquid do not have to be discharged separately, the liquid separator may be omitted. It would then be sufficient to install a pipe $l_{D,}$ leading to a discharge sink.

5.5.4 Installation with gas ejector

In order to achieve certain operating points the vacuum pump will be provided with a gas ejector pump.

5.6 Setting up the unit

A side-mounted liquid separator has to be installed so that the liquid discharge is at the same level as the shaft.

The liquid separator is mounted to the discharge nozzle of the pump..

Select an operating mode that will ensure that as little fresh liquid as possible is needed.

Setting up schema

Descriptions to *Figures 2a-5*

m_B Mano vacuum meter
m_D manometer A discharge liquid
B operating liquid
F clean liquid
K cooling liquid
T expanding agent
U circulating liquid
N liquid level
S medium suction side
D medium discharge side
P liquid ring vacuum pump

PB circulating pump
a liquid separator
b clean liquid container
g gas ejector pump
h ventilating device
w heat exchanger
V_F shut-off valve
V_K shut-off valve
V_S non-return valve
r_B regulating valve
r_F regulating valve
r_{F1} regulating valve (float valve)
r_{F2} regulating valve (thermostatic)
r_{F3} regulating valve (reducing regulator)
l_B pipe for operating liquid
l_F pipe for clean liquid
l_G pipe for cavitation protection
l_K pipe for cooling liquid
l_S suction pipe
l_D discharge pipe
l_U circulating pipe
m_t thermometer
m_{t1} temperature probe to r_{F2}
U_A liquid discharge
U_B connection for operating liquid
U_C cavitation protection
U_V connection for control valve
U_S connection for suction pipe
D_U connection for discharge pipe
U_U connection for circulating liquid
U_e discharge
U_{se} connection for draining pipe
U_{sn} connection for sensor
U_L connection for ventilation device

Figure 2a: Partial Recirculation

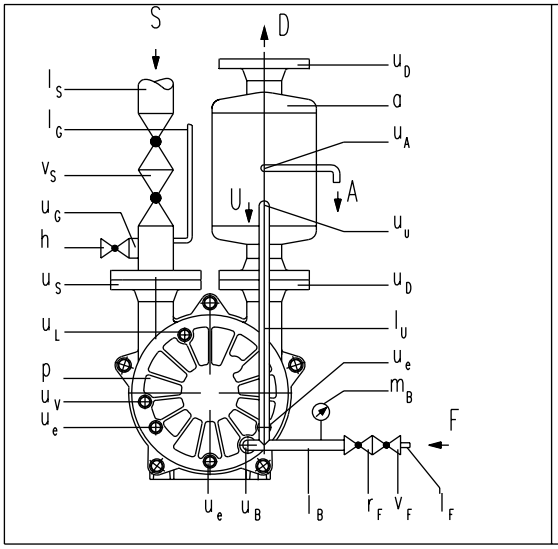


Figure 2b: Thermost-controlled liquid controller

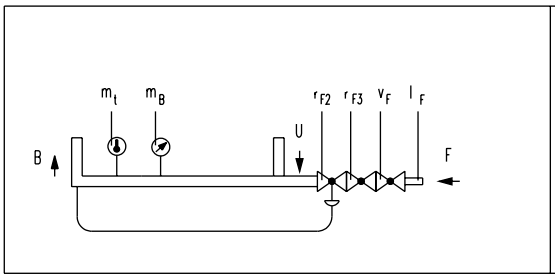


Figure 3: Full recirculation

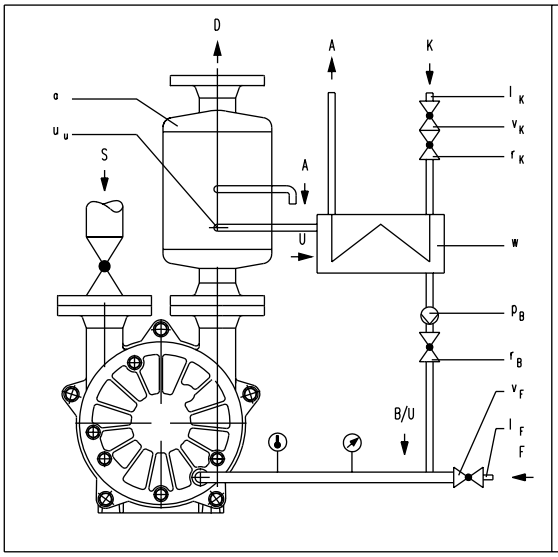


Figure 4a: Once-Through

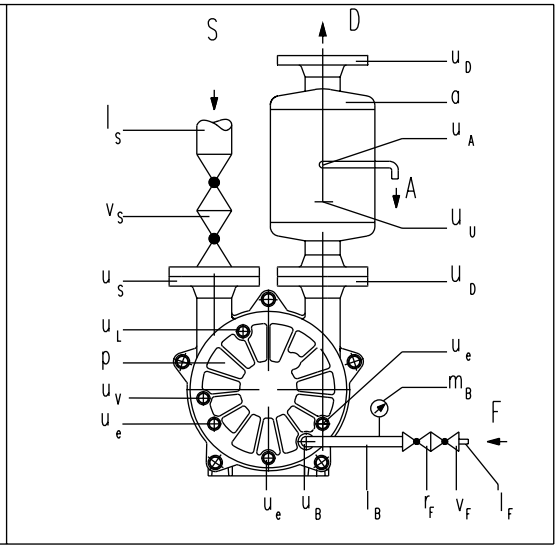


Figure 4b: Container with float valve

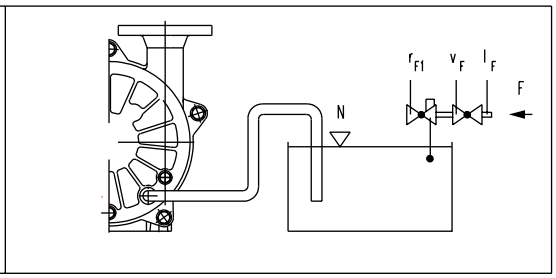


Figure 5: Operation with gas ejector

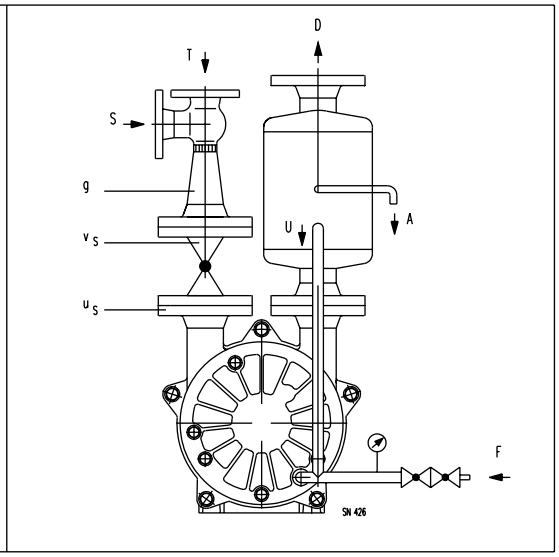
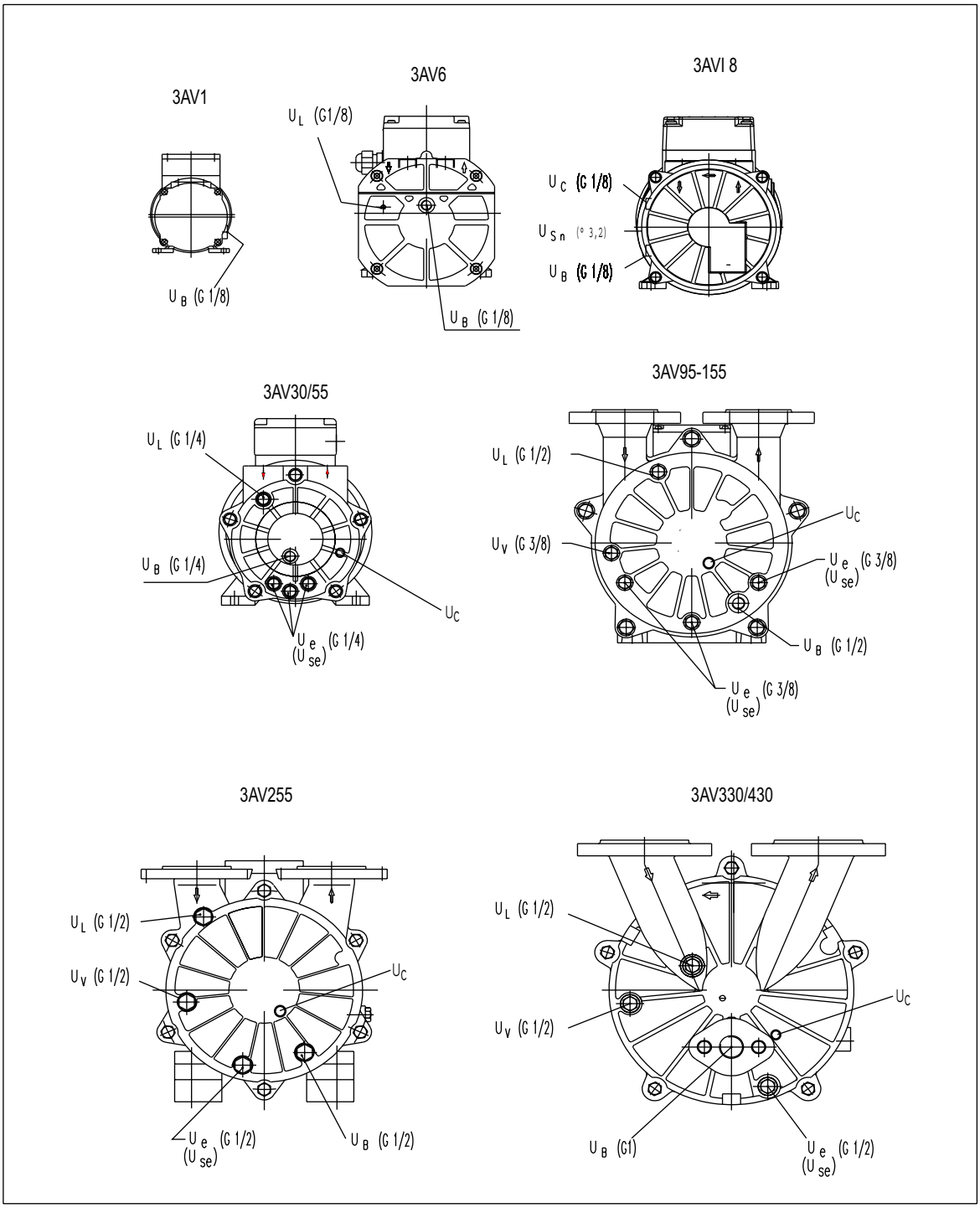


Figure 6: *Position of connection for the process liquid*



Connections	U_B	U_L	U_e	U_V	**Connections**	U_B	U_L	U_e	U_V
3AV1	G1/8"				**3AV330/430**	G1"	G1/2"	G1/2"	G1/2"
3AV6	G1/8"	G1/8"							
3AVI 8	G1/8"								
3AV30/55	G1/4"	G1/4"	G1/4"						
3AV95/155	G1/2"	G1/2"	G3/8"	G3/8"					
3AV255	G1/2"	G1/2"	G1/2"	G1/2"					

6 Commissioning Decommissioning

6.1 Preparing for operation

For commissioning fill the pump with operating liquid up to the middle of the shaft. This may be effected through the suction, discharge, or operating liquid pipe.

CAUTION

Dry running of the pump must be avoided

Check the direction of rotation. Wrong direction of rotation can lead to damage of the mechanical seal.

3AV1-3AV55

In order to control the liquid level *N*, an additional valve in the operation liquid pipe may be required (see *Figure 4b).*

3AV95-3AV430

In order to control the liquid level *N* a valve should be connected to the connection UV. An automatic discharge valve at this connection controls and regulates the liquid level automatically (*Figure 2a*/*4a*).

6.2 Commissioning

- Switch-on motor, open shut-off valve V_F or V_K.
- When starting operation with a closed suction open the relief valve before and close it after having reached the operating speed.

6.3 Adjustment of flow volume

6.3.1 Partial Recirculation according to *Figure 2a*

Open shut-off valve V_F while the pump is running and adjust regulating valve r_F so the pressure at vacuum gauge m_B is about 0 psig (max 3 psig). Block the regulating valve r_F in this position. Maximum temperature of operating liquid see 1.1. The vacuum pump will draw the quantity of clean water as indicated in *Figure 7* (page 12).

6.3.2 Full Recirculation (Figure 3)

While the vacuum pump is running adjust the regulating valve r_F so the pressure at the vacuum gauge m_B is no more than 6 inces Hg Vacuum.

The amount of cooling liquid K will be adjusted through the regulating valve rK at open shut-off device. The regulating valves should be blocked in this position.

6.3.3 Once-Through (*Figure 4a*)

Open shut-off valve V_F while the pump is running and adjust regulating valve r_F, so that the pressure at vacuum gauge m_B is about 0 psig (max 3 psig). The vacuum pump draws the quantity of clean water, as indicated in *Figure 7.*

6.3.4 Thermostat Controlled (*Figure 2b*)

Set the desired temperature of operating liquid. The thermostatic regulating valve r_{F2}. The pressure reducing regulator r_{F3} should be adjusted so that the pressure at vacuum gauge will not exceed 0 psig.

6.4 Decommissioning

Close shut-off device V_F or V_K, switch-off motor, and open ventilation device *h,* if applicable.

If the decommissioning is to allow pump maintenance, lock out the pump from its power source.

When using the pump for hazardous gases, it must be rinsed thoroughly before opening. In order to prevent easily flammable gases causing an explosisive air/gas mixture, the pump should be purged with inert gas before opening and before restarting.

In case of danger of frost or danger of congealing of the ring liquid, pump and liquid separator should be fully drained. This is also applicable for a longer shut-down period.

7 Operation

7.1 General

When handling air and other inert gases water is normally used as the ring liquid. Ring liquids other than water may also be used in order to meet process requirements. The ring liquid must be free of foreign matter which could erode the casing. Use filters as necessary to keep the pump free from contaminants.

At the desired operating temperatures, the kinmatic viscosity should be 4 mm ²/s; higher viscosity in the operating liquid may require a larger motor.

The vapor pressure of the ring liquid should be no more than 16 mbar during vacuum operation at working temperature; higher vapor pressures reduce the suction capacity and final vacuum from those indicated in the performance tables and curves. When ring liquids other than water are used, the performance data of the pump must be confirmed by Airtech.

Condensation of steam in the vacuum pump may cause cavitation and consequently destroy parts of the pump. Therefore, condensation before the vacuum pump is preferable (injection condenser, surface condenser, etc.) In some cases the condensate arising can also be drained into the vacuum pump. For large quantites of condensate, a separate liquid pump may have to be involved.

The published suction capacity will be reached at an operating temperature of 15° C. Operation at higher temperatures will cause a reduced suction capacity.

For vacuum operation with suction pressures below 130 mbar, care should be taken that the operating water temperature is not below 10°C to avoid freezing of the suction nozzle.

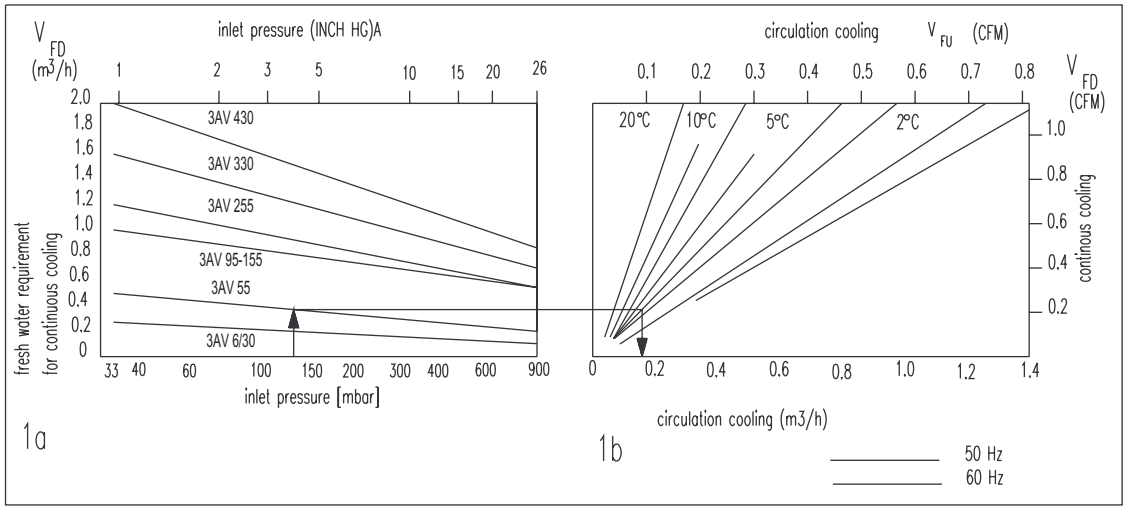
7.2 Fresh Water Requirement

For once-through operation, a fresh water quantity according to Figure 7 is necessary. The fresh water requirement for partial recirculation is also shown in *Figure 7.* The temperature difference Δt (temperature of operating water minus temperature of fresh water) must be stipulated. When the operating temperature is too high for the desired vacuum level, cavitation will occur.

For operation at other rotational speeds, the fresh water requirement is converted proportionally with the change of speed.

For full recirculation systems, the amount of circulating liquid is the same as that for partial recirculation systems.

Figure 7



Example: **3AV 55**

In case of an inlet pressure of 130 mbar the fresh water requirement at continued cooling ISV_{FD} = 0,37 m^3/h, and the fresh water requirement at circulation cooling and a temperature difference Dt = 5°C ISV_{FU} = 0,15m^3/h

Note: 1 m3/nr water =4.4 gpm

7.3 Cavitation: Causes and avoidance

CAUTION

When a shut-off valve is installed in the suction line and the pump is run with the isolation valve closed, cavitation will occur. Consequently parts of the pump can be damaged if the pump is run for a long period.

If mainly steam is handled it will condense during compression, causing cavitation. In order to avoid cavitation, a small quantity of air or other dry gas should be added at suction side. This can be accomplished by:

• A vacuum relief valve *h*,

• Use of cavitation protection; U_C can delay damage due to occasional cavitation.

• Through a connecting pipe (with nozzle) to the liquid separator *a.*

The use of a gas ejector also avoids cavitation (see page 8).

7.4 Contaminated operating liquid, deposits

In the event that fine-grained dust or dirt gets into the pump, it can be rinsed out through the connections U_{SE} during the operation from time to time, in order to avoid wear-out.

When large quantites of dust or dirt will be encountered, the discharge should be cleaned more frequently. When the pump stops it will be emptied. In this case the pipe has to be closed bfore switching off the pump or the pump has to be refilled to the middle of the shaft before recomissioning it.

When operating the pump with water, the hardness of the water has to be strictly observed, as very hard water leads to formation of scale in the pump. In such cases the required water has to be treated (softened) before using it as ring liquid or the pump has to be opened from time to time and the deposits have to be removed. As the impurities (rust, dirt, etc.) are gathered in the liquid separator, it should be cleaned at the same time.

8 Maintenance

Due to their simple and robust construction, the vacuum pumps in closed coupled version need little maintenance. Any maintenance work need -ed will normally result from the operating conditions.

9 Fault Chart

Disturbance	Cause	Action
pump runs loudly	when running with lower suction pressure than indicated (also at closed suction side) or when the percentage of steam in the medium is too high, a grating noise is caused	remedy see 7.2
	quantity of fresh liquid F is too high	liquid in medium D: check position of regulating valve, adjust it
pump does not reach the vacuum capacity specified (pressure/volume)	leakage in system	shut-off device is opened incorrect: check system, seal the leakages
	quantity of operating liquid too small	check pipes and position of regulation valve, adjust it
	temperature of operating liquid is too high	The characteristic curves refer to water with 15° C ring liquid so that at higher operating liquid a reduction of the vacuum and also the suction capacity will be caused. (Reduce the temperature by suitable means)
	Gas or liquid channels are closed	disassemble the pump and clean the channels
	mechanical seal is leaking	change mechanical seal
	quantity of discharge liquid A is too low	check discharge pipe on flow-
pump is blocked	corrosion between rotor and casing	eliminate by use of anti-rust liquid
	ice in pump	ring liquid is congealed: heat it carefully, thaw it
	impurities, foreign bodies in pump	disassemble and clean the pump
power input of pump is too high	quantity of operating liquid too high	adjust the regulating valves
	density or viscosity of liquid too high	the performance data refers to water (1000 kg/m^3, 1 mm^2/s), higher density or viscosity require higher power input. Different operating liquid or bigger motor should be considered
	frictions between impeller and inter casing	disassemble the pump, clean it and adjust the clearances

10 Service Value Limits

	3AV	
pump size	**1**	**6 - 430**
inlet pressure [mbar]	75	33
pressure difference suction- / discharge side [mbar]	200 1030	200 1100
compression pressure [mbar]	1100	1300
gas entry temperature		
dry	200°C	
vapour saturated	100 °C	

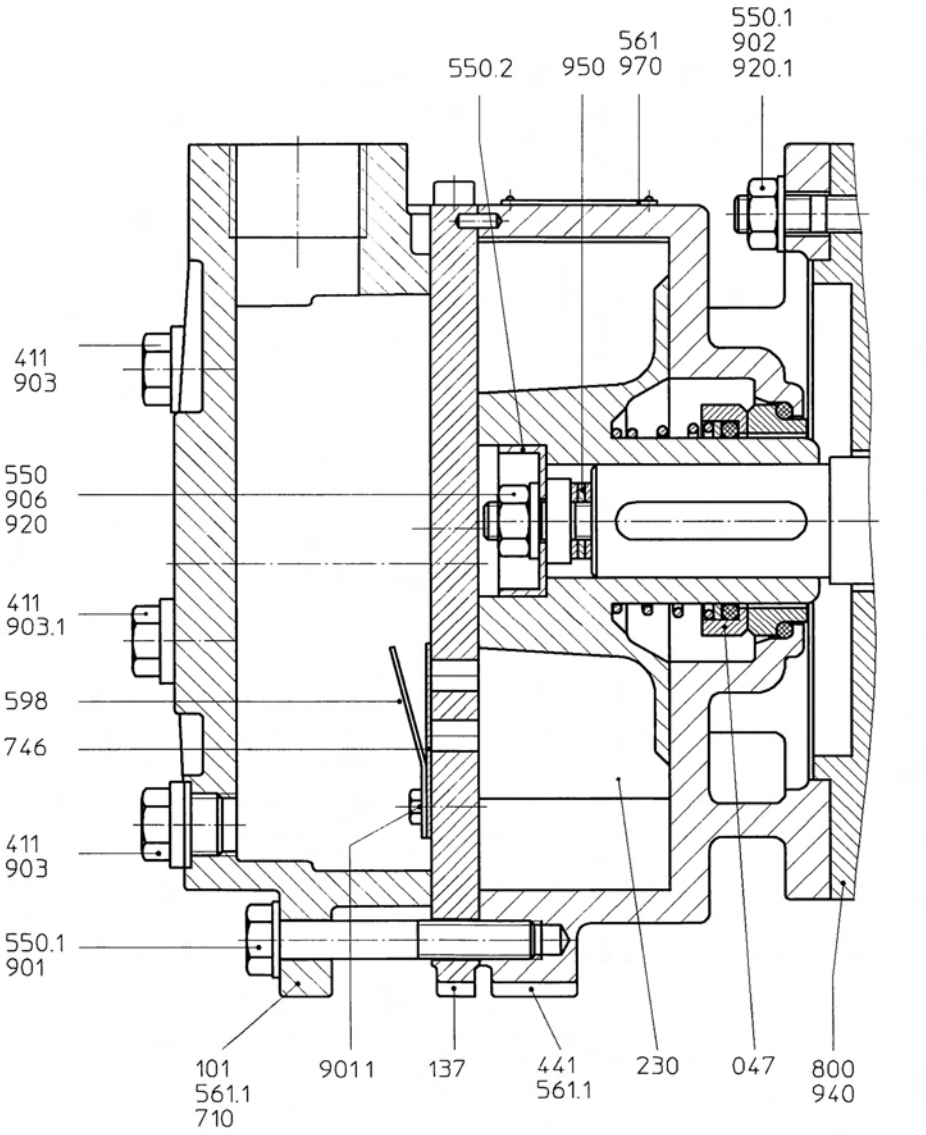
speed [min^{-1}]	**3AV1-55**	**3AV95-420**
50 Hz [60Hz]	2800 [3400]	1450 [1750]

service liquid	
temperature	10 °C 60 °C
density	1200 kg/m^3
viscosity	4 mm^2/s

overpressure for water pressure test	3 bar

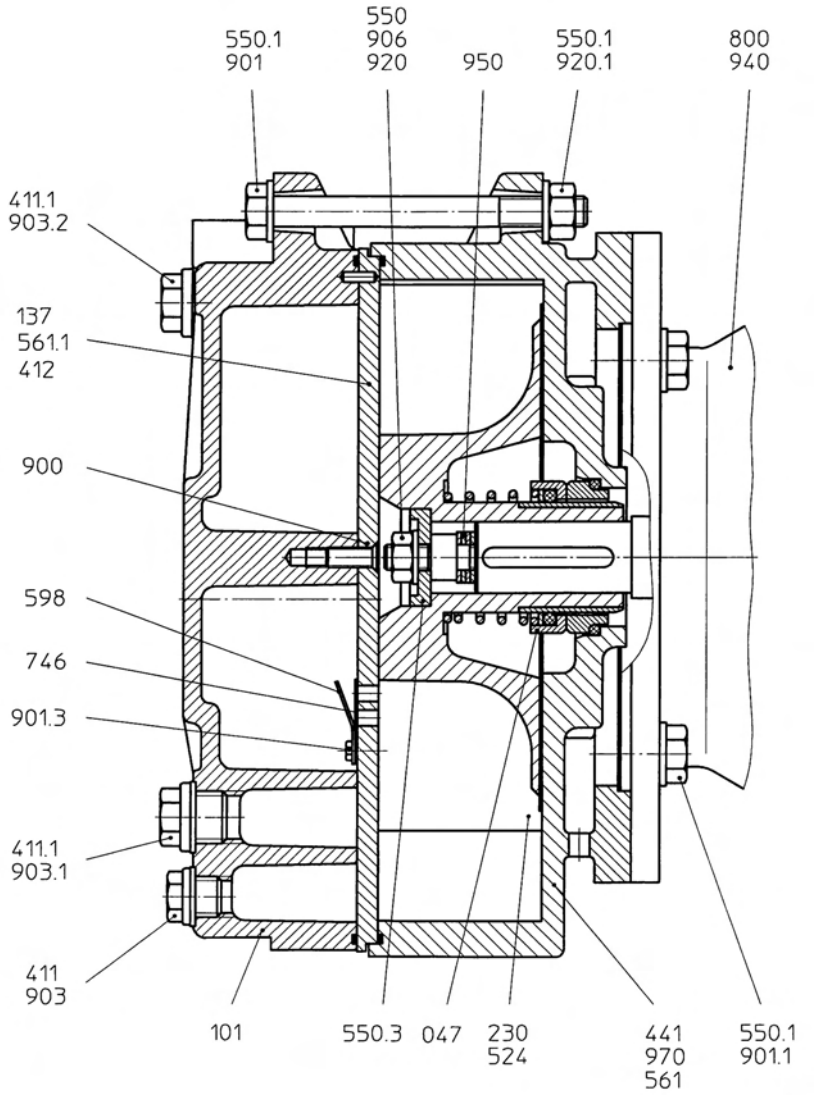
All pressures indicated in mbar are absolute pressures
All values are applicable for a service liquid temperature of 15 °C.

3AV 30/55



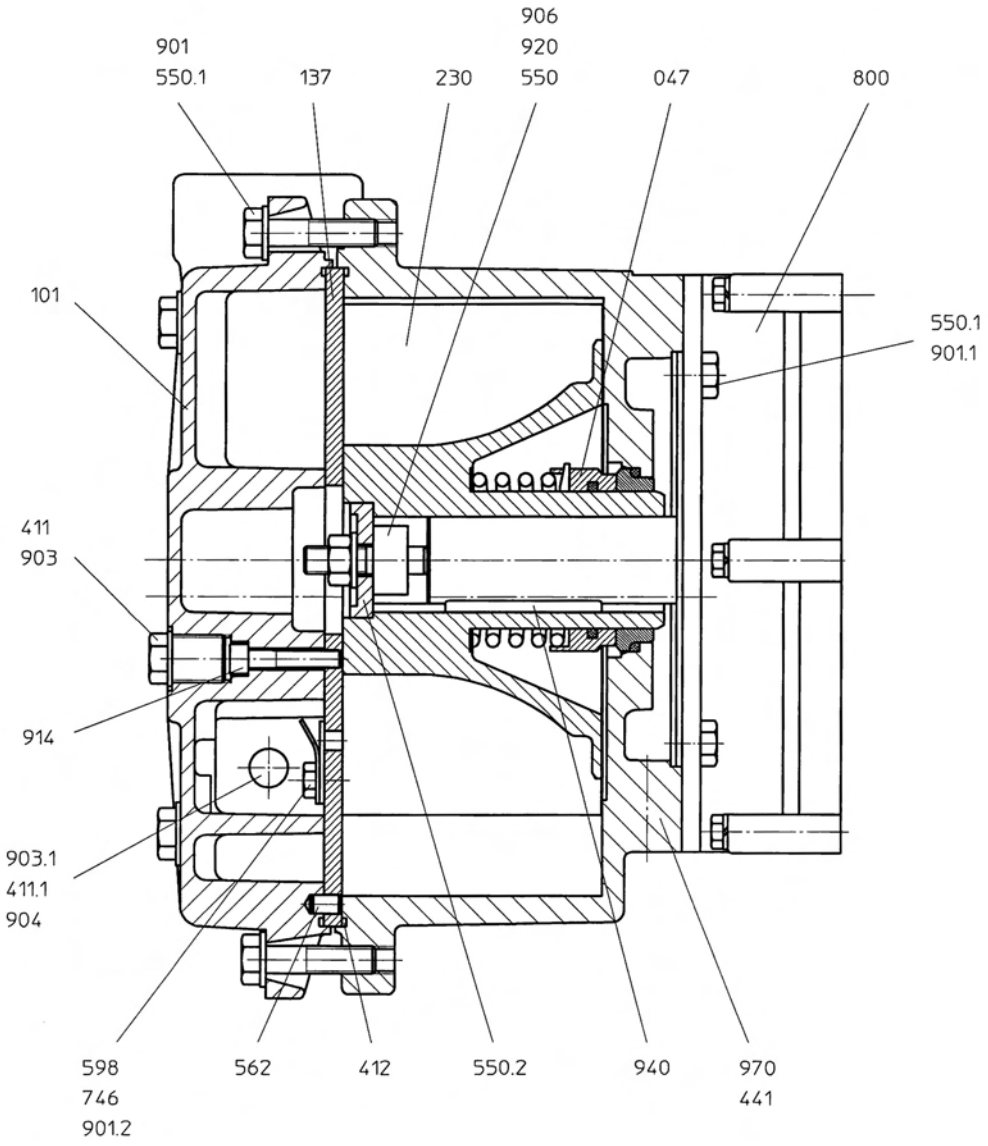
3AV 30/55 Parts			
047	Mechanical Seal	746	Flapper
101	Pump Casing	800	Motor
137	Inter-casing	901	Hexagon Head Cap Screw
230	Impeller	901.1	Hexagon Head Cap Screw
411	Joint Ring	902	Stud
441	Shaft Seal Housing	903	Screwed Plug
550	Disk	903.1	Screwed Plug
550.1	Disk	906	Impeller Screw
550.2	Disk	920	Hexagon Nut
561	Grooved Pin	920.1	Hexagon Nut
561.1	Grooved Pin	940	Key
598	Sheet	950	Spring
710	Sound Damper	970	Shield

3AV 95/130/155



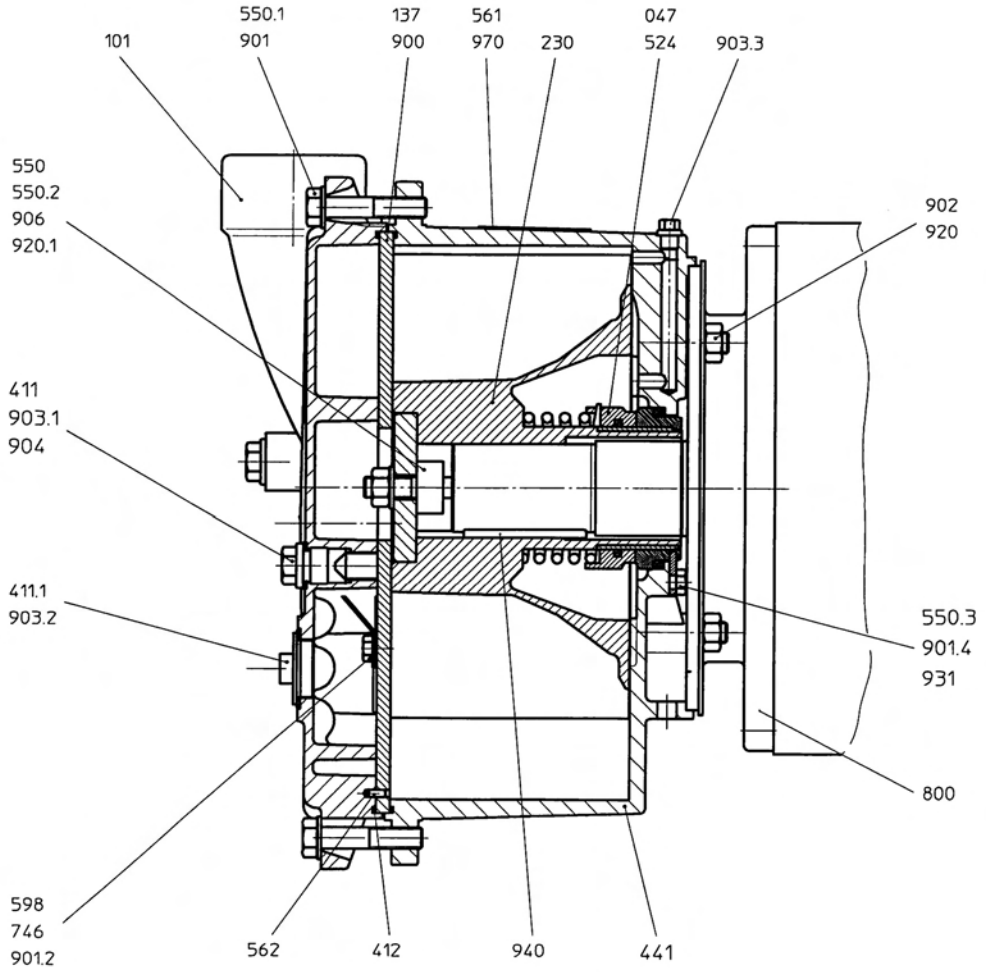
3AV 95/130/155 Parts			
047	Mechanical Seal	746	Flapper
101	Pump Casing	800	Motor
137	Inter-casing	900	Screw
230	Impeller	901	Hexagon Head Cap Screw
411	Joint Ring	901.1	Hexagon Head Cap Screw
411.1	Joint RIng	901.3	Hexagon Head Cap Screw
412	O-Ring	903	Screwed Plug
441	Shaft Seal Housing	903.1	Screwed Plug
524	Shaft Protection Sleeve	903.2	Screwed Plug
550	Disk	906	Impeller Screw
550.1	Disk	920	Hexagon Nut
550.3	Disk	920.1	Hexagon Nut
561	Grooved Pin	940	Key
561.1	Grooved Pin	950	Spring
598	Sheet	970	Shield

3AV 255



3AV 255 Parts			
047	Mechanical Seal	746	Flapper
101	Pump Casing	800	Motor
137	Inter-casing	901	Hexagon Head Screw
230	Impeller	901.1	Hexagon Head Screw
411	Joint Ring	901.2	Hexagon Head Screw
411.1	Joint Ring	903	Screwed Plug
412	O-Ring	903.1	Screwed Plug
441	Shaft Seal Housing	904	Set Screw
550	Disk	906	Impeller Screw
550.1	Disk	914	Screw
550.2	Disk	920	Hexagon Nut
562	Cylindrical Pin	940	Feather Key
598	Stop Sheet	970	Shield

3AV 330/430



3AV 330/430 Parts			
047	Mechanical Seal	800	Motor
101	Pump Casing	900	Screw
137	Inter-casing	901	Hexagon Head Screw
230	Impeller	901.2	Hexagon Head Screw
400	Flat Gasket	901.3	Hexagon Head Screw
411	Joint Ring	901.4	Hexagon Head Screw
411.1	Joint Ring	902	Stud
412	O-Ring	903.1	Screwed Plug
441	Shaft Seal Housing	903.2	Screwed Plug
524	Shaft Protection Sleeve	903.3	Screwed Plug
550	Disk	904	Set Screw
550.1	Disk	906	Impeller Screw
550.2	Disk	920	Hexagon Nut
550.3	Disk	920.1	Hexagon Nut
561	Grooved Pin	931	Locking Washer
562	Cylindrical Pin	940	Feather Key
598	Stop Sheet	970	Shield
746	Flapper		

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