2FBV Series
Liquid Ring Vacuum Pumps
Manual Instruction

www.flugopumps.com

Index

1 Important basic information

1.1 Statement

These operating instructions form part of the technical documentation of the system, and are addressed to the person in charge of the plant, who is obliged to provide them to the staff responsible for the system set-up, connection, operation and maintenance.

He must ensure that all information included in the operating instructions and the enclosed documents have been read and understood.

1.2 Warranty and liability

The manufacture does not accept liability for damage to persons, animals, objects or incomplete observance of the safety precautions included in these operating instructions or by modifications to the system or use of improper spare parts.

Warranty and liability claims arising from physical injury and material damage are excluded if one of the following conditions applies:

-- improper use of the liquid ring vacuum pump.

-- improper mounting, commissioning, operation and maintenance of the liquid ring vacuum pump.

-- operation of the liquid ring vacuum pump despite defective safety devices.

-- non-observance of the notes in the operating instructions.

-- unauthorized constructional changes the liquid ring vacuum pump.

-- inadequate maintenance, repair and servicing measures.

-- catastrophic events caused by foreign bodies or acts of God.

2 Safety

2.1 Staff safety

-- The operator(including electricians and the pump operator) must be trained before working on the pump, and under the supervision of technically qualified staff.

-- The operator must wear protective equipment like helmet, hairnet and gloves.

-- Independent operating is not allowed.

-- Guards for protection against contact with hot, cold and moving parts must not be removed during operation.

-- Only operate the pump in a technically flawless condition and in accordance with the provisions, safety precautions and warnings included in these operating instructions.

-- Notes attached to the pump must be observed and kept legible, e.g. arrows indicating the direction of rotation.

-- The medium to be pumped and operation liquid may be harmful to environment, in case of which, please collect and handle them in an environmental friendly way.

-- In case of defects having safety implications: shut down the aggregate immediately and consult the in charge to rectify the defect.

2.2 Working condition safety

-- The pump can be safely applicated in transmitting dry or wet gases, but the medium to be pumped and operation liquid are not to be explosive, inflammable, aggressive or toxic.

-- Pumps for flammable, exposable poisonous or aggressive media are supplied in accordance with customer specifications.

-- If the pump is used in gaseous environment like gas and coal dust , the mating motor must be accorded with relevant requirements of coal industry safety.

When the pump is used in coal industry, explosion-proof motor of corresponding degree must be mating adopted.

V-belt should be flaming retarding and antistatic.

Monitoring equipment and gas pump pipeline system should be installed.

-- Protection and safety facilities must be equipped to make sure regular working conditions of vacuum pump.

2.3 Safety related terms

The signal terms WARNING, CAUTION, and NOTE: are used in this instruction to point out particular dangers or unusual information which must be particularly noted. It is equally imperative, however, to comply with other notes on transport, assembly, operation and maintenance with technical to avoid faults which, in turn, might directly or indirectly result in severe personal injury or property damage.

Owing to their functional characteristics, such equipment may cause serious personal injury or material damage when improperly used, wrongly operated, insufficiently serviced, or in the event of unauthorized interventions by unqualified individual. This is particularly true of occasions when transporting hot, high-pressure or harmful media.

Mark of coal industry safety production

MA

NOTE

CAUTION

This symbol is labeled on the pump to indicate potentially hazardous situation, which may cause death, physical injury or material damage.

3 Design and functioning

3.1 General description

The pumps of the 2FBV series are horizontal, single-stage liquid ring vacuum pump with radial inlet and outlet.

The electrical drive is modularly screwed to the pump. A maintenance-free mechanical seal in the shaft sealing casing is used to seal the shaft.

The 2BV series pump is able to deliver low liquid flow rates. The discharged operating liquid can be re-used when using a separator.

3.2 Functional principle

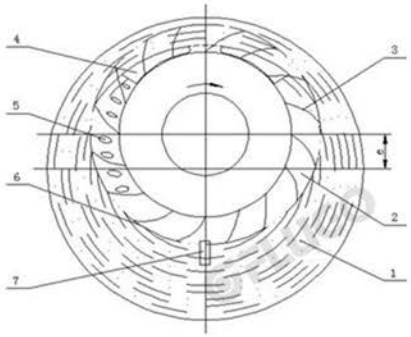


Fig. 1 Functional principle of liquid ring vacuum pump

1. Pump casing
2. Air inlet
3. Impeller
4. Air outlet
5. Oval pressure opening
6. Liquid ring
7. Water inlet opening

• The pump is operated in accordance with the liquid ring principle.

The impeller is positioned off-centre in the cylindrical pump casing, and we name the eccentric distance as “e” for short, as shown in Fig 1. The impeller transfers the drive power to a liquid ring, which forms concentrically to the casing when the pump is started.

The gaseous medium remaining in the casing is distributed around the impeller due to the lower density in the hub area. As the impeller is positioned off-centre to the casing, the available space for the gas between the surface of the liquid and the hub becomes crescent-shaped.

This way, the remaining space for the gas between the blades expands and shrinks during each rotation.

The arrangement of suction and pressure openings in the separate plate allows for the suction, compression and discharge of gas. The liquid both serves the sealing between the individual impeller chambers and the absorption of heat produced during compression.

• The pump must be permanently supplied with operating liquid during operation as a portion of the liquid continuously escapes from the pump together with the gas. The discharged operating liquid can be separated from the gas by means of a downstream separator and re-used.

3.3 Mechanical structure

3.3.1 Sectional structure

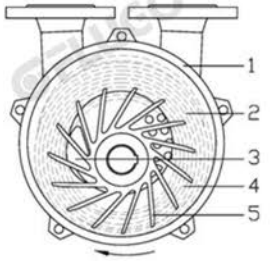


Fig. 2 Sectional drawing

1. Pump cover
2. Air outlet
3. Air inlet
4. Water ring
5. Impeller

3.3.2 2FBV2/2FBV5 series

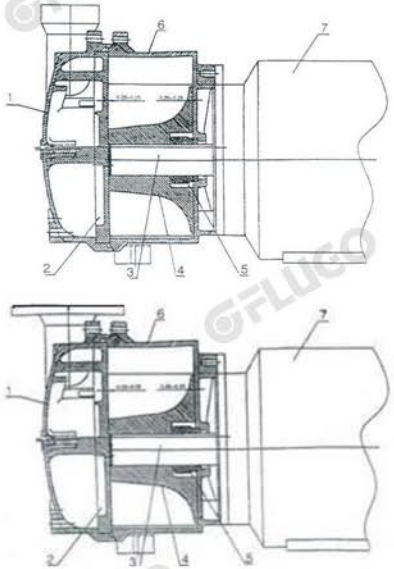


Fig. 3 Mechanical structure of 2FBV2/2FBV5 series

1. Pump cover
2. Separating plate
3. Flat key
4. Impeller
5. Mechanical seal
6. Pump casing
7. Driving motor

3.3.3 2FBV6 series

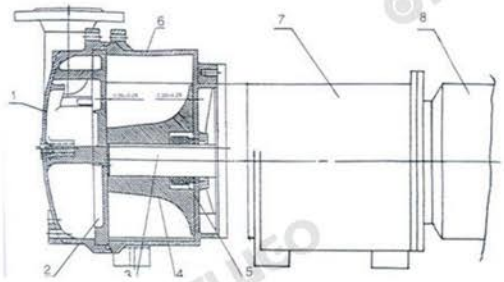


Fig. 4 Mechanical structure of 2FBV6 series

1. Pump cover
2. Separating plate
3. Flat key
4. Impeller
5. Mechanical seal
6. Pump casing
7. Bracket
8. Driving motor

4 Scope of application

4.1 Application

• The 2FBV series are single-stage liquid ring vacuum pumps. They are continuous running to form vacuum. It is suitable for intake and discharge dry and humid gas which are mainly non-flammable, non-corrosive gas and the mixture of gas and vapour.

• According to different customer demands, pumps dealing with flammable, explosive and poisonous media can be supplied. Under such circumstance, the user should take corresponding safety measures.

• Operating liquid is usually water.

• Media to be pumped:

-- Dry and wet gases witch are not explosive, inflammable, aggressive or toxic

-- Air or air-steam mixtures

-which are free of solids

-which contain small amounts of light suspended matters.

• Stainless steel pump is suitable for occasions asking for strict demands of corrosion-proof and sanitation.

• 2BV series pumps create low vacuum, and the ultimate vacuum is decided by saturated vapour pressure of operating liquid.

4.2 Ultimate vacuum

•Ultimate vacuum depends on operating temperature and operating liquid type.

• Please pay attention to the following aspects:

-- If the pump does not have anti-cavitation protection, the suction pressure should not be lower than 80mbar, which is in order to avoid causing cavitation in the pump when the water is 15℃ and the dry air pumped is 20℃.

-- Depending on operating saturated vapour pressure, the higher the temperature, the higher the allowed lowest suction pressure.

-- When the pump is continuously operating, it can make suction until the ultimate vacuum.

-- The higher the temperature is, the lower the suction capability is.

NOTE

Long term running under minimum suction pressure is harmful to the pump!

4.3 Maximum discharge pressure

Using standard operating liquid all the 2FBV vacuum pumps' maximum discharge pressure is 1300mbar.

4.4 Gas and vapor to be pumped

•The medium to be pumped (gas or the mixture of the gas and vapor) containing solid particles is not allowed, but containing little suspended matter or liquid is permissible.

•When pumping extremely hot gas or vapor above 80℃, it is recommended to use double operating liquid volume of the standard flow or use pre-condenser.

4.5 Operating liquid

• Operating liquid must be replenished continuously when pump operating.

• It is not allowed to contain solid particles (e.g. sand etc.), and a filter may be fixed when necessary.

• To make sure enough operating liquid supply, the fed liquid pressure should be 1 bar higher than the suction pressure.

• Operating liquid is expelled together with the gas pumped.

5 Set-up and connection

5.1 Transport and fixing

•2FBVvacuum pump is installed horizontally on surface, and mounted with foundation bolts through bolt holes, (without base frame).

• When slinging and transporting the pump, it is recommended to hook both the sling bolt on the motor and the bolt hole in the suction flange.

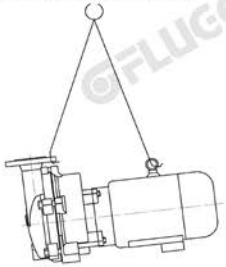


Fig. 5 Lifting the pump

WARNING

Risk of death or contusions from falling goods to be transported!

-- Select lifting gear in accordance with the total weight to be transported.
-- Transport the pump in horizontal position only.
-- Do not stand under suspended loads.

5.2 Pipe connection

• To avoid foreign particle entering the pump, protecting covers are added to all connection openings when delivery and do not remove them before pipe connection completed.

• The connection of pipes should not produce stress and supports should be added on pipes.

5.2.1 Discharge port flange

2FBV-E161: Flange 80ND 10-DIN 2501,
Seal 80ND 6 DIN 2690;

2FBV-E131/2FBV-E121:
Flange 65ND 10-DIN 2501,
Seal 65ND 6 DIN 2690;

2FBV-E110/2FBV110:
Flange 50ND 10-DIN 2501,
Seal 50ND 6 DIN 2690;

5.2.2 Suction port flange

Similar to the discharge port flange, in order to prevent the fixing residue dropping in, e.g. welding slag, it is recommended to install a filter to the suction pipe in the initial 100 hours.

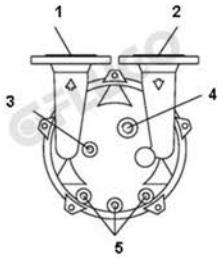


Fig. 6 Pipe connection of cast iron material pump

1. Discharge port
2. Suction port
3. Anti-cavitations connection 3/8
4. Operating liquid connection 3/4
5. Water drainage 3/8

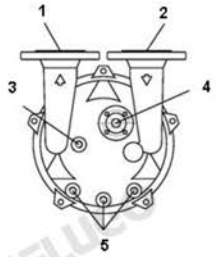


Fig. 7 Pipe connection of stainless steel material pump

1. Discharge port
2. Suction port
3. Anti-cavitation connection
4. Operating liquid connection 3/4
   Flange connection DN15
5. Water drainage 3/8

5.2.3 The recommended mode of the operating liquid connection

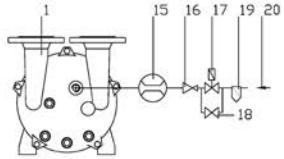


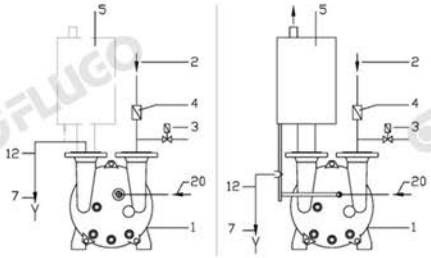
Fig. 8 Example of operating liquid connection

1. 2BV vacuum pump
15. Flow meter (optional)
16. Control valve
17. Solenoid valve (controlled by driving motor)
    (motor starts up-the valve open)
    (motor shuts down- valve close)
18. Bypass pipe globe valve
19. Filter (optional)
20. Feed pipe for operating liquid

5.3 Supply mode of operating liquid

It is a connection to make sure enough operating liquid supply, thus to guarantee minimum suction pressure. The discharged liquid is expelled completely and meanwhile flesh operating liquid replenished.

After filled with water in advance,2FBV vacuum pump can work in the state of automatic water replenishing. Thus, make sure operating liquid to a certain level when staring the pump.



A. Operating liquid circulating pipeline B. Operating liquid circulating pipeline (with separator)

Fig. 9 Supply mode of operating liquid

1.2FBV vacuum pump 2.Suction pipe
3. Vent valve (solenoid valve) 4. Check valve
6. Separator 7. Overflow port
12. Outlet pipe for operating liquid
20. Feed pipe of operating liquid

5.4 Separator

• Separator is used to separate the operating liquid from the expelled gas and allow part of it recycling to the pump, without being cooled. In this way, replenishment of the operating liquid can be reduced.

• Connecting pipes are supplied as accessory with the separator.

• When anti-cavitation protection is needed, the protective pipe is fixed, connecting separator and pump cover.

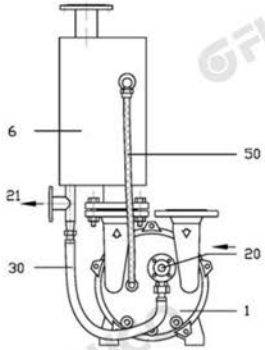


Fig. 10 Separator and cavitations protection

1. 2BV vacuum pump
6. Separator
20. Feed pipe of operating liquid
21. Operating liquid outlet connection
30. Steel pipe or hose
50. Anti-cavitations pipe

5.5 Check valve

• In order to prevent operating liquid from returning after pump shutting down, a check valve is required to be installed in suction pipe.

5.6 Air ejector

• Air ejector is installed in suction side under suction pressure of 10~40mbar.

• It can obtain 10mbar vacuum by adding an air ejector and will not increase power consumption.

• The seal gasket should be concentric with the connection pipe in order to avoid running area reducing.

• The air ejector may function as restriction choke when pumping container in pressure between 1000 and 100mbar.

NOTE

The ejected gas (20℃, 1013mbar atmosphere) cannot contain any water drop.

• In order to reduce draining time, a bypass pipeline can be installed. (⟶Fig.11)

The bypass pipe should be closed before the air ejector takes effect,.

The most suitable working condition to start up the air ejector is 40mbar.

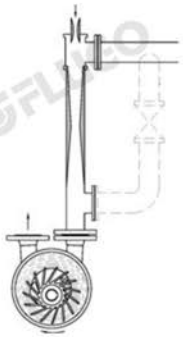


Fig. 11 Bypass pipe

6 Operation

6.1 Preparation

• If there's globe valve on discharge pipe, make sure it is open when pump starting up or shutting down.

WARNING

Risk of material damage caused by dry running!

• Before operating, fill in the pump in advance via suction port or discharge port.

-- Fill 2FBV-E161 with 8 liter operating flow in advance;

-- Fill 2FBV-E131/121/111/110 with 3 liter operating flow in advance.

or :

-- open the bypass valve about 20 seconds to ensure operating liquid flowing into the pump (⟶ Fig8, Page6).

Inspect discharge pipe and operating liquid supply pipe to make sure the connection in good condition.

•Start up the pump instantly to check its rotating direction. The gas in and out direction and the pump shaft rotating direction are labeled as arrows on the pump.

·Compare the rotating direction of the motor fan and the arrow direction on the back of the pump casing. If necessary, the rotating direction of the motor can be changed by changing the two wires.

6.2 Starting up and shutting down

• Start up the pump and check operating liquid flow. If necessary, regulate liquid flow by the control valve (⟶Fig8, 16). Volume flow meter (⟶Fig8.15) is used to obtain standard operating liquid flow.

• If the pump needs to be controlled automatically (installed as Fig8 showing), the operating liquid flow is controlled by solenoid valve(⟶Fig 8.17) which is governed by motor.

Pump operating ----valve opens

Pump shutdown ---- valve closes

• If the pump is not automatically controlled, following steps should be adopted:

-- Start up: start up the pump and then open the globe valve (⟶Fig 8.17) rapidly.

-- Shut down: close globe valve (⟶Fig 8.17), and stop the pump rapidly.

When the 2FBV vacuum pump stops operating, the control valve (⟶Fig 8.16) is closed.

WARNING

Risk of injuries caused by vacuum or harmful media to be pumped and operating liquid!

DANGER

Risk of injuries caused by running pump and motor!

-- Do not touch the running pump

6.3 Draining off

WARNING

If the operating liquid is harmful to human body or environment, for the sake of safety, the pump needs to be flushed during operation, before unscrewing the bolt to drain off.

• To drain off, unscrew the bolt on the pump cover to let the liquid flow out. Meanwhile, turn round the pump by twirling the fan by hand until no liquid flow out.

• The pump can be drained off by making the pump cover 45℃ inclination. In this way the pump can be kept shutdown for a long time or in cold climate, without causing damage to the pump.

7 Maintenance

7.1 Flush the pump

• To avoid impeller and pump casing wearing or impeller blocking, the dust particle entering the pump chamber with the gas and operating liquid should be flushed out via the flushing port in the lower part on the pump cover.

• If hard water is used as operating liquid, it should be softened, or flush the pump with solvent regularly.

7.2 Lubrication

• When using 50Hz motor under normal working conditions:

-- After operating 20000 hours or 3 years at most, clear off the dirt and the discarded grease near the shaft and then replenish with fresh grease.

-- The grease replenished should occupy 50% of the shaft free space and 65% of the bearing cup.

NOTE

Collect contamination and escaping operating liquid and dispose of in an environmentally-compatible way.

• If the working condition is extremely bad, the replacement period of the grease should be correspondingly shortened.

7.3 Storage

• If kept shutdown for about 4 weeks, the pump should be drained off completely in advance. Later it needs to carry on anticorrosive treatment, that is to pour 1/2 liter anticorrosive oil into the pump through the suction port or the discharge port and operate the pump for a short time.

• If the impeller is blocked when keeping prolonged storage after using hard water, the pump chamber should be filled with 10% oxalic acid and keeps for about 30 minutes.

• Make sure the storage room meets the following conditions:

-- dry

-- frost-free

-- protected

-- constant humidity

7.4 Troubleshooting

Defect	Cause	Rectification
Insufficient suction capacity	1. Excessive gap between impeller and inter casing.	Adjust for a correct gap
	2. Air leakage of the packing	Tighten or replace the packing, lower the water supply temperature
	3. Hot temperature of the water ring	Increase operating liquid flow rate
	4. Leakage in pipeline	Tighten flange blots, replace gasket, weld the crackles
	5. Excessive flow resistance in suction pipe	Reduce elbows, replace thick pipes
Insufficient vacuum	A. Pipeline	
	1. Leakage in flange connection	Tighten flange blots/replace gaskets
	2. Crackle on pipes	Weld the crackles/ replace pipe
	B. Water ring	
	1. Air leakage of the packing	Tighten or replace the packing
	2. Excessive gap size between impeller and side cap	Replace gasket, adjust the gap
	3. Operating liquid to got	Cool down the operating liquid
	4. Insufficient operating liquid flow rate	Increase operating liquid flow rate
	5. Hot operating liquid caused by components friction	Adjust/ reassemble
Vibration or strange noise	1. Loose foundation bolts	Tighten foundation bolts
	2. Foreign body grinds in the pump	Shut down the pump and clear the foreign body.
	3. Loose impeller	Replace the impeller
	4. Cavitation	Open the valve of suction pipe
	5. Bearing damage	Replace the bearing
Bearing too hot	1. Insufficient lubrication	Grease the bearing
	2. Packing too tight	Properly loosen the gland cover
	3. No or insufficient sealing water supply	Supply sealing water/Increase
	4. Tight joint between bearing, shaft or bearing bracket lead to small gap and friction among balls and inner ring	Readjust the joints between bearing and shaft/ bearing bracket
	5. Bearing damage	Replace the bearing
Hard startup	1. Rustiness owing to long-term halt	Rotate the shaft towards the direction of pump rotation.
	2. Packing too tight	Properly loosen the gland cover
	3. Impeller rubs against the pump casing.	Disassemble the pump, properly set the gap size between impeller and pump casing
Leakage of mechanical seal	1. Worn-out mechanical seal	Replace mechanical seal
	2. Loose spring of mechanical seal	Adjust the elasticity of spring
	3. Worn-out “O”-ring	Replace the “O”-ring
Sudden shut down	1. Axial rotation of impeller	Tighten the impeller
	2. Pump is blocked by foreign body	Clear the foreign body

Tab. 1 Defect, cause and solutions

8 Technical data

8.1 Technical data (380V 50HZ)

8.1.1 Technical parameter

Curve No.	Model	Max. suction capacity		Ultimate vacuum	Motor power	Motor explosion-proof grade	Motor protection grade	Speed	Operating liquid flow rate	Noise	Weight
		m^3/min	m^3/h	mbar(MPa)	kW			r.p.m	L/min	dB(A)	kg
60V	2FBV2-060	0.45	27	33mbar (-0.097MPa)	0.81	Non-explosion proof	IP54	2840	2.5	62	37
61V	2FBV2-061	0.86	52		1.45			2840	2.5	65	41
70V	2FBV2-070	1.33	80		2.35			2860	3	66	66
71V	2FBV2-071	1.83	110		3.85			2880	4.7	72	85
110V	2FBV5-110	2.75	165		4	Non-explosion proof		1440	7.2	63	120
111V	2FBV5-111	3.83	230		5.5			1440	8.8	68	150
121V	2FBV5-121	4.66	280		7.5			1440	11	69	210
131V	2FBV5-131	6.66	400		11			1460	16	73	280
161V	2FBV5-161	8.33	500		15			970	22	74	390
110V	2FBV6-110	2.75	165		4	dIIBT4	IP55	1440	67	63	150
111V	2FBV6-111	3.83	230		5.5			1440	10	68	200
121V	2FBV6-121	4.66	280		7.5			1440	12	69	230
131V	2FBV6-131	6.66	400		11			1460	17	73	315
161V	2FBV6-161	8.33	500		15			970	23	74	426

Tab. 2 Technical parameter of 380V,50HZ condition

The data above is obtained in condition of:

-- saturated air temperature of media pumped: 20℃,
-- operating liquid temperature: 15℃,
-- discharge pressure: 1013mbar
-- allowance factor ±10%.

8.1.2 Saturated vapor pressure in different temperature

Temperature ℃	22	24	26	28	30	32	34	36	38	40
Vapor pressure MPa	0.00264	0.00298	0.00336	0.00378	0.00424	0.00475	0.00532	0.00594	0.00662	0.00738
Corresponding vacuum MPa	0.09869	0.09835	0.09797	0.09755	0.09709	0.09658	0.09601	0.09539	0.09471	0.09395
Temperature ℃	42	44	46	48	50	52	54	56	58	60
Vapor pressure MPa	0.00820	0.00910	0.01009	0.01116	0.01234	0.01361	0.01500	0.01651	0.01815	0.01992
Corresponding vacuum MPa	0.09313	0.09223	0.09124	0.09017	0.08899	0.08772	0.08633	0.08482	0.08318	0.08141
Temperature ℃	62	64	66	68	70	72	74	76	78	80
Vapor pressure MPa	0.02184	0.02391	0.02615	0.02856	0.03116	0.03396	0.03696	0.04019	0.04365	0.04736
Corresponding vacuum MPa	0.07949	0.07742	0.07518	0.07277	0.07017	0.06737	0.06437	0.06114	0.05768	0.05397
Temperature ℃	82	84	86	88	90	92	94	96	98	100
Vapor pressure MPa	0.05133	0.05557	0.06011	0.06495	0.07011	0.07561	0.08146	0.08769	0.09430	0.10133
Corresponding vacuum MPa	0.05000	0.04576	0.04122	0.03638	0.03122	0.02572	0.01987	0.01364	0.00703	0.00000
Temperature ℃	102	104	106	108	110	112	114	116	118	120
Vapor pressure MPa	0.10878	0.11668	0.12504	0.13390	0.14327	0.15316	0.16362	0.17465	0.18628	0.19854
Temperature ℃	122	124	126	128	130	132	134	136	138	140
Vapor pressure MPa	0.21145	0.22504	0.23933	0.25435	0.27013	0.27831	0.30407	0.33229	0.34138	0.36138

Tab. 10