CALCULATION COOLING COMPRESSORS

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Abstract

In many systems of compressed air, besides the proper selection of the compressor, there are significant opportunities to save energy, including energy recovery, pressure reduction, reducing leakage losses and optimization of systems and control systems. When planning investments in the construction of the compressed air system, it is necessary to examine and evaluate them. In addition, importance must be given to possible future requirements that the system must meet, as well as all other possible influences on the compressed air system. Typical examples of the mentioned influences are the environmental conditions requirements, requirements for energy savings, and increased quality requirements in production and possible future investment in the growth of production. In this paper is explained calculation cooling compressors. Cooling of compressors is going to be done in two cycles. In first cycle technological water circulates by pumps of first cycle. In second cycle "demi" water will circulate and cooled compressors and coolers of compressed air and also will be driven by pumps.

Keywords: pneumatic conveying; cooling; compressor; compressed air.

1. Introduction

Recently, much attention is paid to preserving the environment, and build systems that prevent pollution of the environment. Thermal power plants are one of the biggest environmental polluters. In the process of electricity production as coal combustion products occur large amounts of waste material. Transportation and disposal of fly ash and bottom ash are among the vital technological systems of each power plant that burns coal. The system of transport of fly ash and bottom ash in the thermal power plant can be: transportation by belt conveyors, transportation with dumper-trucks, hydraulic transport and pneumatic conveying [5,9].

The pneumatic transport involves the transportation powder, granular and piece of material and is based on the phenomenon that at the appropriate velocity of air in the pipeline, the solid particles are brought in the desired direction. Selection and efficiency of pneumatic transport depends of physical and chemical characteristic of the fly ash [2,11].

Compressors are mechanical devices used for raising the pressure of gas or vapour either by lowering its volume (as in the case of positive displacement machines) or by imparting to it a high kinetic energy which is converted into pressure in a diffuser (as in the case of centrifugal machines). The selection of compressors for different applications is a crucial

issue in the process industry. It is usually the most expensive piece of equipment and has dominant influence on cycle efficiency. The common types of compressors used in industry are reciprocating, twin screw, single screw, centrifugal, scroll and rotary vane. In this paper is explained calculation cooling compressors. For properly system sizing ability, it is important to know the system function condition, pipe network, equipment position, and conveying medium characteristics (in this case compressed air) [3,6,10].

In this paper is presented a system of preparation and distribution of compressed instrument air to the consumer in the system of internal pneumatic transport of fly ash under the electrofilter, flues and steam air heaters and calculation cooling compressors. System of compressed air for electrofilter is an integral part of a whole, the pneumatic transport of fly ash for the silo. The quantity of fly ash shown in table 1 and list of design input data are shown in tables 2 and 3.

Input data	Value
Fly ash:	165 – 232,2 t/h
Ash from boiler hoppers and air preheater hopper: (this ash is included in the sum for fly ash)	14,0 – 17,8 t/h

Table 1. The quantity of ash produced by one unit

Input data	Value
Bulk density of fly ash	0,74 t/m ³
Specific mass density	2,22 g/cm ³

Table 2. Design data

Input data	Value
Long distance fly ash pneumatic conveying	260 t/h per unit (including 15% reserve)

Table 3. Capacity data of the system

2. Technical description

2.1. Compressed air distribution

Compressed air is distributed by seamless steel galvanized pipelines. Distribution pipeline is oriented towards consumers, apropos to all valves on pneumatic drive which are located under electrofilter (EPS) of unit 1 and unit 2, and to the consumers in pump stations 1 and 2. In function of assigned pressure, complete pipeline is dimensioned, apropos diameters of certain sections are specified.

2.2. Compressed air consumers

Compressed air is used for manipulation and control in pneumatic transport process as well as for manipulation of pneumatic valves which are within automatic control of pneumatic transport. Locations which are supplied with compressed air: pressure vessels for pneumatic fly ash transport, air transport pipeline, armatures of ash receiver (plate gate valves), ash transport pipelines and pneumatic valves in bager station. Consumers, apropos places which are needed to be supplied with compressed air, altogether there are 226 pieces. Function of these valves is in program control of fly ash transport process which is managed by PLC. Safe operation of installation, apropos maintaining pressure in installation within limitations of minimal and maximal permissible pressure is supplied with regulation system which is located in the compressor. Compressor is in mutual automatic operation with reservoir of instrumental air where pressure should be between 6,3 – 7,5 bars. When pressure in reservoir drops under 7,5 bars, and reaches value of minimum permissible operation pressure $p_{\min} = 6,3$ bars, automatically one compressor activates until maximal wanted pressure is not reached [4].

3. Selection of compressor for compressed air under electrofilter

- Air consumption by consumer for transimtion in block 1 : $Q_1 = 53 \text{ m}^3/\text{h}$.
- Air consumption by consumer for transimtion in block 2: $Q_2 = 53 \text{ m}^3/\text{h}$.
- Air consumption by consumer for transimtion in pump stations 1 and 2 like consumers on air preheaters and under channel of flue gases: $Q_3 = 15 \text{ m}^3/\text{h}$.
- Total air consumption increased for 20% : $Q = 1,2 \cdot (Q_1 + Q_2 + Q_3) = 1,2 \cdot 121 = 145,2 \text{ m}^3/\text{h}$.

On the basis of calculated consumption of 145,2 m³/h compressor of firm Atlas Copco is selected:

Type: GA15+, Capacity: 160 m³/h , Operation pressure: 7,5 bara , Power of electromotor: 15 kW, Noise level: 64 dB, Dimensions 1400 x 1225 x 650 [1,4].

Fig 1. Compressor

On the base of selected compressor and according to Atlas Copco recommendation absorption dryers type CD 44 (2 piece) are chosen (Fig. 1). And on the base of experience in designing system of compressed air, instrumental air reservoir is selected, volume $V = 2 \text{ m}^3$.

4. Calculation cooling compressors

Compressors (Fig. 2) of compressed air are water cooled, while compressors of control air are air cooled. Water for cooling of compressed air and compressors is used in secondary circuit which is closed. A water tank will be used to supply additional water should any losses of water occur during circulation. Water from primary circuit is supplied from unit 1 and flows to bager station. Circulation pump, heat exchanger and pipeline were selected in accordance with calculation.

Fig 2. Compressors

4.1. Calculation of quantity of water for cooling of compressor and compressed air of secondary circuit

Calculation of quantity of water for cooling of compressor and compressed air of secondary circuit be calculated according to the following:

$$Q_{uk} = 5Q_{k1} + 2Q_{k2} \quad (1)$$

where $Q_{k1} = 11,5l/s = 41,4m^3/h$ is quantity of water for cooling of compressor and compressed air ($Q=5600m^3/h$) and $Q_{k2} = 4,66l/s = 16,7m^3/h$ is quantity of water for cooling of compressor and compressed air ($Q=940m^3/h$).

$$Q_{uk} = 5 \cdot 41,4 + 2 \cdot 16,7 = 240m^3/h$$

Reserve of water for one compressor is applied in above ($Q=5600 m^3/h$).

4.1.1. Determining dimensions of secondary circuit pipeline of cooling water

Determining dimensions of secondary circuit pipeline of cooling water is given by:

$$d = \sqrt{\frac{4 \cdot Q_{uk}}{\pi \cdot v}}, \quad (2)$$

where $v = 2$ m/s is assumed water velocity in cooling pipeline.

$$d = \sqrt{\frac{4 \cdot 240}{\pi \cdot 2 \cdot 3600}} = 206mm$$

Nominal diameter DN 200 ($\varnothing 219,1 \times 5,9$) is selected.

4.1.2. Calculation of actual water velocity in pipeline

Actual water velocity in pipeline be calculated according to the following:

$$v = \frac{4 \cdot Q_{uk}}{\pi \cdot d_p^2} = 1,97m/s, \quad (3)$$

where is $d_p = 219,1 - 2 \times 5,9 = 207,3 \text{ mm} = 0,2073 \text{ m}$.

Water velocity in cooling pipeline:

$$v = \frac{4 \cdot 240}{\pi \cdot 0,2073^2 \cdot 3600} = 1,976m/s.$$

4.1.3. Pipeline features and local losses

Length of pipeline is $L = 60m$. List of pipeline features and local losses is shown in table 4.

Pipeline features	Local losses
10 elbows $90^\circ R = 3D$	$10 \cdot 0,5 = 5$
10 elbows $45^\circ R = 3D$	$10 \cdot 0,5 = 5$
20 valves	$20 \cdot 0,6 = 12$
6 T- pieces	$6 \cdot 0,6 = 3,6$
	$\Sigma \xi = 25,6$

Table 4. Pipeline features and local losses

4.1.4. Calculation of pressure drop in secondary cooling circuit

Pressure drop in secondary cooling circuit can be determined by:

$$\Delta p_u = \Delta p + \Delta p_k + \Delta p_i, \quad (4)$$

where $\Delta p = \Delta p_1 + \Delta p_2$ is pressure drop in pipeline (Δp_1 - pressure drop in straight pipe and Δp_2 - pressure drop due to local losses), $\Delta p_k = 0,55 \text{ bar}$ is pressure drop through compressors and $\Delta p_i = 0,45 \text{ bar}$ is pressure drop through heat exchanger.

Pressure drop in straight pipe should be calculated according to the following:

$$\Delta p_1 = \lambda \frac{L}{d_p} \cdot \frac{v^2}{2g}, \quad (5)$$

where $\lambda = 0,0144 + 0,00947/\sqrt{v} = 0,0211$ is coefficient of air friction using Weissbach method.

$$\Delta p_1 = 0,12 \text{ bar}.$$

Pressure drop due to local losses should be calculated according to the following:

$$\Delta p_2 = \frac{v^2}{2g} \cdot \zeta, \quad (6)$$

where $\zeta = 25,6$ is local losses and pressure drop in pipeline is given by:

$$\Delta p_2 = 0,528 \text{ bar}$$

and pressure drop in pipeline

$$\Delta p = 0,12 + 0,528 = 0,648 \text{ bar}.$$

Pressure drop in secondary cooling circuit can be determined by (4):

$$\Delta p_u = 0,648 + 0,55 + 0,45 = 1,65 \text{ bar}.$$

4.1.5. Selection of circulation pump in secondary circuit

Pump power is given by:

$$N = \frac{Q_{uk} \cdot H_p \cdot \rho \cdot g}{367 \cdot \eta}, \quad (7)$$

where $\rho = 1000 \text{ kg/m}^3$ is water density in secondary circuit, $\eta = 0,7$ is coefficient of device usage, Q_{uk} - total water flow in secondary circuit and H_p - pump head.

Total water flow in secondary circuit can be determined by (1):

$$Q_{uk} = 5 \cdot 41,4 + 2 \cdot 16,7 = 240 \text{ m}^3 / \text{h},$$

where $Q_{K1} = 11,5 \text{ l/s} = 41,4 \text{ m}^3 / \text{h}$ is quantity of water for cooling of compressor and compressed air ($Q = 5600 \text{ m}^3 / \text{h}$) and $Q_{K2} = 4,66 \text{ l/s} = 16,7 \text{ m}^3 / \text{h}$ is quantity of water for cooling of compressor and compressed air ($Q = 940 \text{ m}^3 / \text{h}$).

Pump head should be calculated according to the following:

$$H_p = \Delta p_i + \Delta p_k + \Delta p, \quad (8)$$

where $\Delta p_i = 0,45 \text{ bar}$ is pressure drop in heat exchanger, $\Delta p_k = 0,55 \text{ bar}$ is pressure drop in compressor and $\Delta p = 0,65 \text{ bar}$ pressure drop local losses.

$$H_p = 0,45 + 0,55 + 0,65 = 1,65 \text{ bar}$$

Pump power can be determined by (7):

$$N = \frac{240 \cdot 1,65 \cdot 1 \cdot 9,81}{367 \cdot 0,7} = 15,1 kW.$$

$$N_m = \frac{N}{\mu}, \quad (9)$$

where $\mu=0,9$ is coefficient of device safety,

$$N_m = 16,8 kW.$$

Standard pump motor with $N=18,5$ kW will be used.

The characteristics of the pump:

Firm: WILO, Type: IL150/260-18,5/4, Flow range: 216 m³/h, Motor power: 18,5 kW and Weight 309 kg [7].

4.2. Selection of circulation pump in primary circuit

Total water flow in primary circuit can be determined by:

$$\dot{m}_{iv} = \frac{i_2^{ul} - i_2^{iz}}{i_1^{iz} - i_1^{ul}} \cdot \dot{m}_{dv}, \quad (10)$$

where are:

$\dot{m}_{dv} = 60,02 l / s = 216 m^3 / h$ - total water flow in secondary circuit,

$i_2^{ul} = 209,34 kJ / kg$ ($t = 50^\circ C$) - enthalpy secondary circuit water at outlet heat exchanger,

$i_2^{iz} = 167,53 kJ / kg$ ($t = 40^\circ C$) - enthalpy secondary circuit water at inlet heat exchanger,

$i_1^{ul} = 117,37 kJ / kg$ ($t = 28^\circ C, p = 3,5 bar$) - enthalpy primary circuit water at inlet heat exchanger,

$i_1^{iz} = 142,25 kJ / kg$ ($t = 35^\circ C, p = 3,5 bar$) - enthalpy primary circuit water at outlet heat exchanger.

$$\dot{m}_{iv} = \frac{209,34 - 167,53}{142,25 - 117,37} \cdot 60,02 = 100 l / s = 360 m^3 / h$$

4.2.1. Determining dimensions of primary circuit pipeline of cooling water

Determining dimensions of primary circuit pipeline of cooling water is given by:

$$d = \sqrt{\frac{4 \cdot \dot{m}_{iv}}{\pi \cdot v}}, \quad (11)$$

where $v=2$ m/s is assumed water velocity in cooling pipeline.

$$d = \sqrt{\frac{4 \cdot 360}{\pi \cdot 2 \cdot 3600}} = 252,3 mm$$

Nominal diameter DN 250 (Ø273 X 6,3) is selected.

4.2.2. Calculation of actual water velocity in pipeline

Actual water velocity in pipeline be calculated according to the following:

$$v = \frac{4 \cdot \dot{m}_{iv}}{\pi \cdot d_p^2}, \quad (12)$$

where is $d_p = 273 - 2 \times 6,3 = 260,4 mm = 0,2604 m$.

$$v = \frac{4 \cdot 360}{\pi \cdot 0,2604^2 \cdot 3600} = 1,88 \text{ m/s.}$$

4.2.3. Pipeline features and local losses

Length of pipeline is $L = 700 \text{ m}$. List of pipeline features and local losses is shown in table 5.

Pipeline features	Local losses
15 elbows $90^\circ R = 3D$	$15 * 0,5 = 7,5$
2 elbows $45^\circ R = 3D$	$2 * 0,5 = 1$
2 elbows $30^\circ R = 3D$	$2 * 0,5 = 1$
6 valves	$6 * 0,6 = 3,6$
6 T- pieces	$6 * 0,6 = 3,6$
	$\Sigma \xi = 16,7$

Table 5. Pipeline features and local losses

4.2.4. Calculation of pressure drop in primary cooling circuit

Pressure drop in straight pipe should be calculated according to the following (5):

$$\Delta p_1 = 1,02 \text{ bar}$$

where $\lambda = 0,0144 + 0,00947/\sqrt{v} = 0,0211$ is coefficient of air friction using Weissbach method.

Pressure drop due to local losses should be calculated according to the following (6):

$$\Delta p_2 = 0,3 \text{ bar},$$

where $\xi = 16,7$ is local losses and pressure drop in pipeline should be calculated according to the following:

$$\Delta p = 1,02 + 0,3 = 1,32 \text{ bar}.$$

Pressure drop in secondary cooling circuit can be determined by (4):

$$\Delta p_u = 1,32 + 0,55 + 0,45 = 2,32 \text{ bar},$$

where $\Delta p_k = 0,55 \text{ bar}$ is pressure drop through compressors and $\Delta p_i = 0,45 \text{ bar}$ is pressure drop through heat exchanger.

4.2.5. Selection of circulation pump in primary circuit

Pump power is given by:

$$N = \frac{\dot{m}_v \cdot H_p \cdot \rho \cdot g}{367 \cdot \eta}, \quad (13)$$

where $\rho = 1000 \text{ kg/m}^3$ is water density in secondary circuit, $\eta = 0,7$ is coefficient of device usage, H_p - pump head and $\dot{m}_v$ - total water flow in primary circuit ($99 \text{ l/s} = 360 \text{ m}^3/\text{h}$).

Pump head should be calculated according to the following (8):

$$H_p = 0,45 + 0,55 + 1,32 = 2,32 \text{ bar},$$

where $\Delta p_i = 0,45 \text{ bar}$ is pressure drop in heat exchanger, $\Delta p_k = 0,55 \text{ bar}$ is pressure drop in compressor and $\Delta p = 1,32 \text{ bar}$ pressure drop local losses.

Pump power can be determined by (13):

$$N = \frac{360 \cdot 2,32 \cdot 1 \cdot 9,81}{367 \cdot 0,7} = 31 \text{ kW},$$

and

$$N_m = \frac{31}{0,9} = 35 \text{ kW},$$

where $\mu = 0,9$ is coefficient of device safety.

Standard pump motor with $N = 45 \text{ kW}$ will be used.

The characteristics of the pump: Firm: WILO, Type: IL200/320-45/4, Flow range: 360 m³/h, Motor power: 45 kW and Weight: 512 kg [7].

4.3. Calculation of area heat exchange

4.3.1. Characteristics of water in secondary circuit

$p_1 = 100 \text{ kPa}$ - water pressure in secondary circuit,

$t_2^{ul} = 50^\circ \text{C}$ - inlet water temperature in secondary circuit exchanger,

$t_2^{iz} = 40^\circ \text{C}$ - outlet water temperature in secondary circuit exchanger and

$\dot{m}_{rv} = 66 \text{ l/s}$ - mass flow of water.

4.3.2. Water performance in primary circuit

$p_2 = 3,5 \text{ bar} = 350 \text{ kPa}$ - pressure water of primary circuit,

$t_1^{ul} = 28^\circ \text{C}$ - inlet temperature water in heat exchanger primary circuit and

$t_1^{iz} = 35^\circ \text{C}$ - outlet temperature water in heat exchanger primary circuit.

4.3.3. Heat quantity which receive primary circuit water

Heat quantity which give in secondary circuit water be calculated according to the following:

$$Q_d = \dot{m}_{rv} (i_2^{ul} - i_2^{iz}) \quad (14)$$

where are:

$i_2^{ul} = 209,34 \text{ kJ/kg}$ ($t = 50^\circ \text{C}$) - enthalpy secondary circuit water at outlet heat exchanger,

$i_2^{iz} = 167,53 \text{ kJ/kg}$ ($t = 40^\circ \text{C}$) - enthalpy secondary circuit water at outlet heat exchanger and

$$Q_d = 66 (209,34 - 167,53) = 2759,46 \text{ kW}.$$

Heat quantity which receive primary circuit water be calculated according to the following:

$$Q_{rv} = \eta \cdot Q_d, \quad (15)$$

where $\eta = 0,985$ is coefficient of used heating.

$$Q_{rv} = 2759,46 \cdot 0,985 = 2718 \text{ kW}$$

4.3.4. Calculation of area heat exchange

Flow of technological water through heat exchanger can be determined by:

$$\dot{m}_{iv} = \frac{Q_{iv}}{(i_1^{iz} - i_1^{ul})}, \quad (16)$$

$$\dot{m}_{iv} = \frac{2718}{(142,45 - 117,37)} = 108 \text{ l/s}.$$

Area of heat exchange is given by:

$$A_{iv} = \frac{Q_{iv} \cdot K}{\Delta T_{\log}}, \quad (17)$$

where Q_{iv} is heat quantity which receive primary circuit water (technical water), $K = 1/R$ is coefficient of resistance of heat passage, $R = 4,5 \frac{\text{Wm}^2}{\text{K}}$ is resistance of heat passage and $\Delta T_{\log}$ is middle logarithmic temperature.

Middle logarithmic temperature be calculated according to the following:

$$\Delta T_{\log} = \frac{\Delta T_v - \Delta T_m}{l_n \frac{\Delta T_v}{\Delta T_m}}, \quad (18)$$

$$\Delta T_{\log} = \frac{(t_2^{ul} - t_1^{iz}) - (t_2^{iz} - t_1^{ul})}{l_n \frac{t_2^{ul} - t_1^{iz}}{t_2^{iz} - t_1^{ul}}}, \quad (19)$$

$$\Delta T_{\log} = \frac{(50 - 35) - (40 - 28)}{l_n \frac{50 - 35}{40 - 28}} = \frac{3}{l_n \frac{15}{12}} = 13,44.$$

Area of heat exchange should be calculated according to the following (17):

$$A_{iv} = \frac{2718 \cdot \frac{1}{4,5}}{13,44} = 44,94 \text{ m}^2$$

The characteristics of the plate heat exchanger: Firm: Alfa Laval, Test pressure: 13 bar, Design pressure: 10 bar, Min. temperature: 0 °C, Netweight: 941 kg and Operating weight: 1117 kg [8].

5. Conclusion

The selection of compressors for different applications is a crucial issue in the process industry. It is usually the most expensive piece of equipment and has dominant influence on cycle efficiency. In this paper is presented a system of preparation and distribution of compressed instrument air to the consumer in the system of internal pneumatic transport of fly ash under the electrofilter, flues and steam air heaters and calculation cooling compressors. System of compressed air for electrofilter is an integral part of a whole, the pneumatic transport of fly ash for the silo.

Compressed air is distributed by seamless steel galvanized pipelines. Distribution pipeline is oriented towards consumers, apropos to all valves on pneumatic drive which are located under electrofilter (EPS) of unit 1 and unit 2, and to the consumers in pump stations 1 and 2. In function of assigned pressure, complete pipeline is dimensioned, apropos diameters of certain sections are specified.

Compressed air is used for manipulation and control in pneumatic transport process as well as for manipulation of pneumatic valves which are within automatic control of pneumatic transport. Locations which are supplied with compressed air: pressure vessels for pneumatic fly ash transport, air transport pipeline, armatures of ash receiver (plate gate valves), ash transport pipelines and pneumatic valves in bager station. Consumers, apropos places which are needed to be supplied with compressed air, altogether there are 226 pieces. Function of these valves is in program control of fly ash transport process which is managed by PLC. Safe operation of installation, apropos maintaining pressure in installation within limitations of minimal and maximal permissible pressure is supplied with regulation system which is located in the compressor. Compressor is in mutual automatic operation with reservoir of instrumental air where pressure should be between 6,3 – 7,5 bars. When pressure in reservoir drops under 7,5 bars, and reaches value of minimum

permissible operation pressure $p_{\min} = 6,3$ bars, automatically one compressor activates until maximal wanted pressure is not reached.

Selection of compressor for compressed air under electrofilter: air consumption by consumer for transmission in block 1 : $Q_1 = 53 \text{ m}^3/\text{h}$, air consumption by consumer for transmission in block 2: $Q_2 = 53 \text{ m}^3/\text{h}$, air consumption by consumer for transmission in pump stations 1 and 2 like consumers on air preheaters and under channel of flue gases: $Q_3 = 15 \text{ m}^3/\text{h}$ and total air consumption increased for 20% : $Q = 1,2 \cdot (Q_1 + Q_2 + Q_3) = 1,2 \cdot 121 = 145,2 \text{ m}^3/\text{h}$.

On the basis of calculated consumption of $145,2 \text{ m}^3/\text{h}$ compressor of firm Atlas Copco is selected: Type: GA15+, Capacity: $160 \text{ m}^3/\text{h}$, Operation pressure: 7,5 bara, Power of electromotor: 15 kW, Noise level: 64 dB, Dimensions $1400 \times 1225 \times 650$. On the base of selected compressor and according to Atlas Copco recommendation absorption dryers type CD 44 (2 piece) are chosen. And on the base of experience in designing system of compressed air, instrumental air reservoir is selected, volume $V = 2 \text{ m}^3$.

Compressors of compressed air are water cooled, while compressors of control air are air cooled. Water for cooling of compressed air and compressors is used in secondary circuit which is closed. A water tank will be used to supply additional water should any losses of water occur during circulation. Water from primary circuit is supplied from unit 1 and flows to bager station. Circulation pump, heat exchanger and pipeline were selected in accordance with calculation.

In this paper is explained calculation cooling compressors. Cooling of compressors is going to be done in two cycles. In first cycle technological water circulates by pumps of first cycle. In second cycle "demi" water will circulate and cooled compressors and coolers of compressed air and also will be driven by pumps. Possible water lost through cooling process will be refunded from additional water tank which is connect with supplying water pipe line for cooling. Selection of circulation pump in secondary circuit (the characteristics of the pump): Firm: WILO, Type: IL150/260-18,5/4, Flow range: $216 \text{ m}^3/\text{h}$, Motor power: 18,5 kW and Weight 309 kg and selection of circulation pump in primary circuit: Firm: WILO, Type: IL200/320-45/4, Flow range: $360 \text{ m}^3/\text{h}$, Motor power: 45 kW and Weight: 512 kg. The characteristics of the plate heat exchanger: Firm: Alfa Laval, Test pressure: 13 bar, Design pressure: 10 bar, Min. temperature: 0°C , Netweight: 941 kg and Operating weight: 1117 kg. Optimized operation of the compressor is becoming increasingly important, especially for larger systems of compressed air depending on the industry. As the production rate in plants grow with plant development, the operating conditions of the compressor will change. It is therefore important that the compressed air supply system is based both on the current needs, and the needs in the future.

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