Starting air system for shipping vessels engineering essay

Environment, Air

Introduction

Our project is about shipping vessels on how it starts their engines by having the “ starting air system”. We want to use the LabView to remotely control all the mechatronics parts. To simulate that electronic and mechanical components are been integrated to perform the task.

The purpose of having a “ starting air system” is because the shipping vessels have large diesel or gas turbine engines. It designed to have high compression ratio, the purpose is to fully utilize the fuel consumption. So this air system is created to facilitate the initial starting up of those huge vessels engines.

The two compressors build up the pressure and store it into the pressure vessels which will be direct into the engines. The compressor air will be injected into the engines cylinder that comprises of a piston. It will be input over the top dead center of the cylinder. This action caused the cylinder to moves into a downward position and this movement will be transfer to other pistons in line of the engine to start the rotation. Gradually, the fuel will be input to the cylinders and then the compressed air will be cut off.

Another reason of using this “ starting air system” because it is able to performed the “ blown over” procedure. It ensure there no water inside the engine by releasing out the compress air and blowing out any water content inside the engine as it will hinder the performance of the engine.

The complete “ starting air system” comprised of these several main components: two electric motors driven compressors, four pressure vessels and one compressor remote controller, solenoid drain valves and alarm to notify the operator when there any fault to the system.

System Architecture

The architecture of the starting air control system is divided into two (2) parts.

Control Part

One (1) ‘ Start/Stop’ push button for 1st compressor motor;

One (1) ‘ Start/Stop’ push button for 2nd compressor motor;

One (1) ‘ Compressor 1 fault’ push button to simulate 1st compressor fault;

One (1) ‘ Compressor 2 fault; push button to simulate 2nd compressor fault;

‘ Stop’ push button to stop the program;

Monitoring Part

One (1) ‘ Green’ running indication light for 1st compressor motor;

One (1) ‘ Green’ running indication light for 2nd compressor motor;

One (1) ‘ Red’ fault indication light for 1st compressor motor;

One (1) ‘ Red’ fault indication light for 2nd compressor motor;

Pressure gauge for four (4) pressure switches;

Pressure bar to monitor all pressure switches;

Both compressor fault unable to start indication;

System Communication

The communication between the control and monitoring part is designed by logic diagram, and detailed description as follow;

Input/output

Inputs

Compressor No. 1 Start button

Compressor No. 2 Start button

Compressor No. 1 Stop button

Compressor No. 2 Stop button

Compressor No. 1 High pressure setting

Compressor No. 1 Low pressure setting

Compressor No. 2 High pressure setting

Compressor No. 2 Low pressure setting

Pressure Switches

Compressor No. 1 fault simulation button

Compressor No. 2 fault simulation button

Outputs

Compressor No. 1 running indication

Compressor No. 2 running indication

Compressor No. 1 fault indication

Compressor No. 2 fault indication

Both Compressors fault unable to start indication

Pressure indication

Logic

Preset the high pressure (30 bars) and low pressure (27 bars) for 1st compressor on the panel;

Press ‘ Start’ button for the 1st compressor.

Else do nothing.

AND ‘ Green’ running indication for the 1st compressor is enabled.

IF the pressure reaches the pre-set high pressure value – 30 bars, THEN the 1st compressor is stopped automatically.

Else do nothing

AND ‘ Green’ running indication for the 1st compressor is disabled.

IF the pressure drops till the pre-set low pressure value – 27 bars, THEN the 1st compressor is started automatically.

Else do nothing

AND ‘ Green’ running indication for the 1st compressor is enabled.

Loop the 1st compressor start/stop automatically when high pressure at 30 bars and low pressure at 27 bars.

Press ‘ Compressor No. 1 fault’ button to simulate the 1st compressor fault.

AND Red ‘ Fault’ indication light for the 1st compressor is enabled.

AND ‘ Start/Stop’ push button for the 1st compressor is disabled.

Press ‘ Start’ button for the 2nd compressor.

Else do nothing.

AND ‘ Green’ running indication for the 2nd compressor is enabled.

IF the pressure reaches the pre-set high pressure value – 30 bars, THEN the 2nd compressor is stopped automatically.

Else do nothing

AND ‘ Green’ running indication for the 2nd compressor is disabled.

IF the pressure drops till the pre-set low pressure value – 27 bars, THEN the 2nd compressor is started automatically.

Else do nothing

AND ‘ Green’ running indication for the 2nd compressor is enabled.

Loop the 2nd compressor start/stop automatically when high pressure at 30 bars and low pressure at 27 bars.

Press ‘ Compressor No. 2 fault’ button to simulate the 2nd compressor fault.

AND Red ‘ Fault’ indication light for the 2nd compressor is enabled.

AND ‘ Start/Stop’ push button for the 2nd compressor is disabled.

IF press both ‘ Compress No. 1 and No. 2 fault’ button to simulate both compressor fault in the system.

Else do nothing

AND ‘ Both fault unable to start’ indication is enabled.

AND both compressors ‘ Start/Stop’ push button is disabled.

Components description

Electrical motors driven compressors

The electric motors which are to be used is the produced by Siemens, the model is 1LA5 186-6AA60. It weight 123 kilogram and runs on a three phases, 440voltage and 60 hertz with a rated current of 32A. These motors

are capable of producing a power of 18. 0KW, a power factor of 0. 83 at full load. It has a synchronous speed of 1200rpm and rotating in a clockwise direction. It is constructed based on these standards; IP55 for protection, design according to IMB3 while the size and dimensions are based on IEC60072. This unit wiring are connected in DELTA. The recommended condition for the compressor to work in the ambient temperature of not exceeds 45 degree Celsius.

This is a two cylinder, two stage compressor. The cylinders are fitted in a V-shape at 90 degree angle to each other. Cylinders and compressed air coolers are air-cooled by a built in fan. A well-dimensioned fresh air duct must be provided to the location, where the compressor is installed. The mouth of the duct should be as close as practically possible to the suction side of the cooling fan. The ambient temperature should not exceed 45 degree C. The fan supplier cool air for circulation purpose.

Supply pressure is determined by adjusting the safety valve. Normally the compressor and motor are fitted together on a strong base plate. Instrumentation is supplied in accordance with classification standard requirement.

A sigh class is provided to check the oil level in the sump. Or an automatic low oil level alarm can be supplied as extra option. Bearing and cylinder walls are splash lubricated

If the compressor unit is installed with resilient mounting so a flexible hose must be installed in the compressed air pipe. An oil and water separator

should be fitted at some distance from the compressor and need to arrange of a position that the line slopes downwards from the compressor to the separator. It is recommended to provide the oil and water separator with both manual and automatic draining. Equipment for automatic draining is available as an optional extra and our “ air starting system” do has this option. All piping must be well secured and free from vibration.

Oil level sensor

The purpose of having this oil level sensor is to detect the present of any oil content in the compressor before start running it. This device ensure the compressors are fill with oil which is essential for the motor; lubrication for the moving mechanism part. Using the “ SPERRE”, model number is 4356 that requires a power supply of 230VAC and a maximum switching current of 1 ampere. The maximum rating power consumption is 26VA/20Watt and ingress protection class is IP65.

The contacts are normally set for “ normally open” operation. Example, the contact are closed when the lubricating oil level is high enough. For adjustment, the locking screw has to be released and the switching unit has to be moved, so that the “ RED” arrow (normally open operation) or the “ WHITE” arrow (normally closed operation) is located at the input of the cross drilling.

Solenoid drain valve

Solenoid drain valves will be installed to unload and drain of the compressor air in the system as per requirement by the engines. It will be using this type

of solenoid valve; the brand is SPERRE and the part number is 4332. The solenoid duty will be continuous. The valve is always in open state and will only close upon been energized. This is a “ Pilot operated diaphragm valve”, where it will be mounted to predetermined position of the pipe with a nominal diameter of 14. 5mm. By controlling of the air it could expand or deflate the diaphragm to shut-off or open through the position of the valve stem.

It weight 880grams including of the coil and the working maximum pressure of 40bar.

A supply of alternating current of 220volt (50/60Hz) is needed to trigger it where the voltage tolerance is between -10% to +15% of nominal. The power rating at 8Watt and all these features are oblige to IP65 protection class. The life expectancy will be up to hundred thousand of cycles.

Pressure switch PRS-30

The adjustable pressure switch PRS-30 (Brand “ SPHERE”, part number: 7756) will be integrated into the starting air system. It is used to send signal to the controller when to start or stop the compressor when the pressure in the vessel is either dropping beyond it set point or reaches the sufficient stage. The working range is between 3. 5 to 35 bars and with a weight of 750grams. The maximum permissible pressure is up 45bar per cycle and able to withstand a pressure of 160bar of the destruction state. This is a type of diaphragm pressure switch that consist of two switches; “ High setting

point (PH)” and the “ Low setting point” (PB). When the incoming pressure exceed the high or low point, there will be an electronic signal been sent.

Temperature switch TMS-80

For the temperature switch, we decide to use the SPERRE TMS-80 (Part number: 7746). It is an adjustable temperature switch that is used for alarm indication and also to shut down the compressor in the scenario where it exceeds the set temperature. This rigid temperature sensor switches weight merely of a 350grams. It needs to be operating in an environment condition range between -40 to +70 degree Celsius. While it’s setting range is between +50 to +100 degree Celsius with a differential of 3 degree Celsius. The switch works on the principle of “ single pole with double throw (SPDT)”, where a contact “ common” will be in the position of either one line at a time, L1 or L2. This is driven by a supply of 250VAC, 0. 5 ampere and it vibration stability is abide to IEC68-2-6 standard; sinusoidal vibration of 20g, 2-25Hertz.

User manual

Personal Safety on Handling of Compressor

~ Personal safety when handling the compressor which is catered only to compress air. Before engaging any form of work, the electrical power need to be turn off at the starter panel.

~ Secondly, the discharge valve need to be close and the compressed air has to be released from the compressor system.

~ The safety valves of the “ Low Pressure (LP)” and the “ High Pressure (HP)” air and other safety equipment must be inspected regularly. Original parts that had been damaged need to be replaced, original parts, adjustment of the safety valves shall only be carried out by authorized personnel. The compressor must never be used if the safety equipment is defective. High compressor air can cause damage to the entire system as well as to the maintenance personnel.

Starting Up

Before initial starting up and after long periods out of use, carry out the following operations in the sequence given;

Check the oil level (sight glass).

If the compressor has been out of service for more than 6 months, remove valves and lubricate cylinder walls.

Turn the compressor by hand.

Open valves on compressed air line, and start the unit.

Check that all components are running normally. Inspect instruments, check for air leaks.

Operation

During operation, pressures and temperatures must be within the recommended limits. Any deviation is abnormal and it’s cause should be ascertained by means of the fault tracing chart. In the case of pressure or

temperature deviations, it is recommended first to check the values with new thermometers and pressure gauges in order to ensure that the fault is not to be found in the instruments.

Coolers

If to ensure a trouble-free operation it is importance to ensure that the cooler are kept clean and free of any foreign matter at all times. If the coolers are not kept properly clean, high air temperature will result with a consequent reduction of working life of valves and cylinders.

The coolers can be externally cleaned by spraying on a good grease solvent and then blowing them clean with compressed air.

In the case of heavy deposits of dirt the coolers should be dismantled for external and internal cleaning.

Any carbon deposits in the tubes can be removed by placing them in a bath of carbon remover or similar solvent overnight, and then flushing with hot fresh water.

Functional Block Diagram

Program description:

The starter is designed with a “ Manual” and “ Auto” switch

In “ Manual” mode the compressor will run regardless of the start/stop pressure switch. It is not recommended to leave the compressor running unattended in “ Manual” mode although the parameters temperature.

In “ Auto” mode the compressor is controlled by the start/stop pressure switch.

The starter is equipped with a common alarm signal lamp and a common alarm signal output. The alarm signal is a voltage free contact programmed to be closed when the compressor condition is normal. This mean that the alarm signal is open if it is not running or there is a fault condition detected.

Following parameters will give alarm:

High temperature => If the temperature exceeds the setting of the temperature switch the compressor will stop and alarm will sound. The alarm will remain until reset button is pressed. The text “ High Temperature” will be displayed and remain in the display until the reset button is pressed.

Lubrication oil failure => If the lubrication oil level/pressure falls under the setting of the lubrication oil switch, the compressor will stop and alarm will be given. The alarm will remain until the reset button is pressed.

Motor overload => If the thermal overload relay releases, the compressor will stop and alarm will be given. The alarm will remain until the thermal relay is reset.

Emergency Stop => when the emergency stop push button is activated, the compressor will stop and alarm will be given. The alarm will remain until the emergency stop push button is released and the reset is pressed.

The program is designed to auto start (to simulation the scenario manually) after blackout and if it is set at “ Auto”. However, if the compressor is in “ Manual” mode and there is a power blackout then the compressor will not restart when the power returns but have to switch back to “ Auto”.

Front Panel Diagram

Front panel description:

Reference to above front panel diagram for starting air control system, the system consists of the following software push button on the display panel;

Compressor 1/2 Start/Stop push button – to start or stop the compressor 1/2;

Compressor 1/2 Running indication – to indicate the running condition for compressor 1/2;

Compressor 1/2 Fault indication – to indicate the fault condition for compressor 1/2;

High pressure setting – to set the high pressure to cut off the compressor 1/2 power supply;

Low pressure setting – to set the low pressure to start the compressor 1/2;

Gauge 1 to 4 – to display the pressure for the four (4) pressure vessels base on pre-set pressure setting;

Pressure bar – to indicate the average pressure for four (4) pressure vessels;

Compress 1&2 fault – to simulate the compressor 1 or 2 fault condition to active the another compressor to start automatically;

Both fault unable to start – to indicate both compressors are under fault condition, and all start/stop buttons for both compressors are disabled.

Instruction for Running Simulation

Above starting air control system flow control diagrams are shown the conceptual of the labview

Case One (1)

Preset the high pressure at 30 bars for Compressor No. 1;

Preset the low pressure at 27 bars for Compressor No. 1;

Press Compressor No. 1 start button;

Run the simulation;

The pressure will increase from 0 bar to 30 bars;

The Compressor will be stopped when the pressure reach at 30 bars;

The pressure start dropping when 1bar per second when the 1st compressor stop;

When the pressure drop to 27 bars, the 1st compressor start automatically;

Loop the program (30 bars stop the compressor No. 1, 27 bars start automatically) till pressing the stop button.

Case Two (2)

Preset the high pressure at 30 bars for Compressor No. 1;

Preset the low pressure at 27 bars for Compressor No. 1;

Preset the high pressure at 30 bars for Compressor No. 2;

Preset the low pressure at 27 bars for Compressor No. 2;

Press Compressor No. 1 start button;

Run the simulation;

The pressure start increasing from 0 bar;

Press Compressor No. 1 Fault simulation button;

The Compressor No. 1 Fault indication is enabled, pressure starts dropping;

When pressure reach at 0 bar, the 2nd Compressor starts automatically;

Loop the program (30 bars stop the compressor No. 2, 27 bars start automatically) till pressing the stop button.

Case Three (3)

Press Compressor No. 1 and No. 2 Fault simulation button;

Both Fault Unable to start indication is enabled;

Start/Stop push button for both Compressor No. 1 and No. 2 are disabled;

Conclusion

The compressed air starting system is used to jump start the engine before combusting the fuel. The air is been compressed to 30bar and the pressure vessels are to be maintained at that level. The “ Air Starting System” can be in “ Manual” or “ Auto” mode to control the compressed air supplying to the engine during initial start-up. The system is able monitor the pressure and trigger on the compressors when the pressure dropped below the specification. It also can be control through a manual mode where the operator can adjust the pressure base on the situation.

This air starting system could help the ship industrial to save fuel and indirectly reduce the carbon monoxide emission.