Development Of Control Algorithm For Automation Of Desiccant Air Dryer Using Plc

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***Abstract*- In this paper, the project introduces about need of Automation technique in Process industry. The efficient Programmable Logic Controller is used for controlling the Desiccant dryer process. The Programs are created by the working Logics of the Desiccant Dryer. The timing Cycle of the Valves are taken as the important logics of the process. The Valve opening Periods are taken as the outputs of the PLCs. The comparator is used for the Comparison between the running times of the two consecutive processes. In between those timings the particular valves will be opened for the process. The monitoring process is accurate in this PLCs controller that minimize the manual errors and the cost of the manual controller by using relays and timers are more which will be reduced by the PLC Automation technique.**

***Index Terms*- Desiccant Dryer, Automation technique, Programmable Logic Controller.**

I. INTRODUCTION

1.1 AIR DRYER : Compressed air is used in a wide variety of industrial applications. Wherever it is used, compressed air must be clean and dry. Containing solid, liquid and gaseous contaminants, untreated compressed air poses a substantial risk as it can damage your air system and end product. Moisture, one of the main components of untreated air can cause corrosion in pipe work, premature failure of pneumatic equipment, product spoilage and more. An air dryer is therefore essential to protect your systems and processes. When the air that surrounds us is compressed, its water vapour and particle concentration increases dramatically. For example, compressing ambient room air to 7 bar(e)/100 psig increases the vapour content or humidity by a factor of around 8, and subsequent cooling forms liquid water. The amount of water depends on the specific application. Compressed air can actually contain three forms of water: liquid water, aerosol (mist) and vapour (gas). An efficient means of removing water from compressed air is therefore vital.

1.2 Moisture in the air can be particularly problematic, causing:

- Corrosion of compressed air piping.
- Damages & malfunction of air powered equipment.
- Compressed air leakages due to corroded pipes.
- Poor paint quality, deterioration of electrostatic painting processes.
- Deteriorated end product quality.

1.3 Air Drying :

These are two basic modes of removal of moisture (drying of air) from compressed air:

- Adsorption drying.
- Refrigeration drying.

Adsorption drying works on the basic principle of mass transfer i.e. adsorption of moisture from compressed air by desiccant like Silica Gel, Activated Alumina or Molecular Sieves. These types of air dryers are economical when extremely dry air having atmospheric dew point of -40 °C or lower is required. On the other hand, Refrigerated air dryer works on the principle of cooling down air to -3 °C by a suitable refrigerant like Freon, NH_3 Etc.

II. DESICCANT DRYER

The term "desiccant dryer" refers to a broad class of dryers. Other terms commonly used are regenerative dryer and twin tower dryer, and to a lesser extent adsorption dryer. The compressed air is passed through a pressure vessel with two "towers" filled with a media such as activated alumina, silica gel, molecular sieve or other desiccant material. This desiccant material attracts the water from the compressed air via adsorbtion. As the water clings to the desiccant, the desiccant "bed" becomes saturated. The dryer is timed to switch towers based on a standard NEMA cycle, once this cycle completes some compressed air from the system is used to "purge" the saturated desiccant bed by simply blowing the water that has adhered to the desiccant off.

2.1 DUTY OF THE DESICCANT:

The duty of the desiccant is to bring the pressure dew point of the compressed air to a level in which the water will no longer condense, or to remove as much water from the compressed air as possible. A standard dew point that is expected by a regenerative dryer is −40 °C (−40 °F); this means that when the air leaves the dryer there is as much water in the air as if the air had been "cooled" to −40 °C (−40 °F). Required dew point is dependent on application and −70 °C is required in some applications. Many newer dryers come equipped with a dew dependent switching (DDS) which allows for the dryer to detect dew point and shorten or lengthen the drying cycle to fulfill the required dew point. Oftentimes this will save significant amounts of energy which is one of the largest factors when determining the proper compressed air system. The regeneration of the desiccant vessel can be during three different methods: Heatless "pressure-swing" drying, which uses part of the dry compressed air coming from the other vessel to dry the desiccant in the vessel being regenerated at lower pressure. 17-20% purge rate Heated dryer, which uses a hot air blower, so there is no loss of compressed air. >7% Purge Rate. Heat of compression, which can only be used with an oil free compressor.

2.2 PROCESS FLOW DIAGRAM OF DESICCANT DRYER:

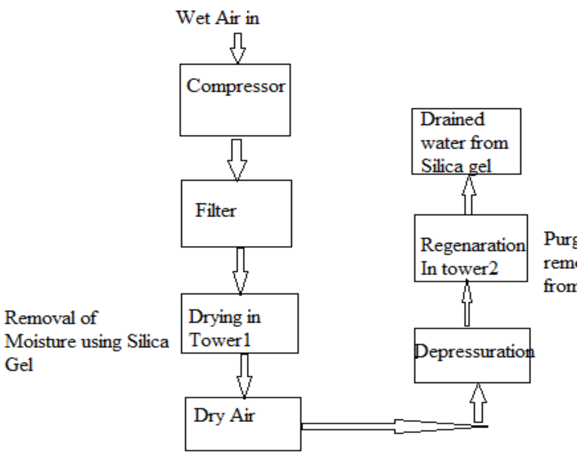


Fig.2.1 Process Flow Diagram of Desiccant Dryer

2.3 USAGE:

Drying air for use in commercial or industrial processes that demand dry air:

- Telecomm industry (pressurizes its underground cables to repel moisture and avoid shorts)
- Painting
- Pneumatic tools
- Textile Manufacturing
- Pneumatic control systems
- Feed air for Zeolite type Oxygen and Nitrogen generators
- Dental Office air
- Truck and Train Air brake systems.

2.4 PROCESS :

The compressed air passes through twin towers which filled with activated allumina, silica gel, molecular sieves. These desiccant material absorb the water vapours from the compressed air and the material bed becomes saturated by absorbing the water vapours. when one tower is generation while other tower under regeneration in that case dry air from saturated tower purging through the regenerating tower which carry water itself from the tower.

III. SYSTEM DESCRIPTION

Each Dryer plant a skid mounted double towered desiccant-based dryers. In a dryer at any point of time one tower will be in adsorption mode and the other in regeneration mode simultaneously. They will change their mode after every 8 hours of operation, effected by valves operation. If this is interrupted due to any reason, then the operation duration will be counted from the accumulated duration just before the interruption. The control is effected by relay-based logics developed in local control panel (LCP) in the dryer common control room at EL 93.5. Hand switches are provided to select the mode of operations and all the annunciations and indications are provided in the LCP.

3.1 PRINCIPLE OF OPERATION: The compressed air enters through the pre-filters, then dried by the tower which is in drying mode, where moisture contents are removed and then again passed through the after-filters to instrument air consumers. The sequence of operation is detailed out below with the DR-01 in operation and DR-02 in standby mode. In DR-01, Adsorber 'A' is considered to be in drying mode and the Adsorber 'B' in regeneration mode. The detailed operation are as follows (refer the Process & Instrumentation Drawing KAPP-3&4 /75106 /6001/ P&ID)

3.2.1Process in Adsorber 'A' (ADSR-2001) during 0 to 480 minute:

The saturated compressed air enters the dryer at nozzle N1 and reaches the Pre-filter (FR-2003 OR FR-2004). Pre-filter (FR-2003 OR FR-2004) filters the solid particles from the incoming compressed air down to 3 micron. The filter elements shall be periodically cleaned. Some amount of bulk moisture is also separated by this filter by an auto drain valves. The filtered & saturated air enters into the Adsorber 'A' (ADSR-2001) where the indicative type silica gel adsorbs moisture from the compressed air. This process is called 'Drying'. This process extends up 480 minute in a cycle of 960 minute. Thus the compressed air leaving the Adsorber 'A' (ADSR-2001) will be dried out of moisture to the required dew point. While passing through the Adsorber the dry air would carry some particles/impurities from the bed of silica gel. These particles/impurities will be filtered by after filter (FR-2005 OR FR-2006) down to 3 micron. Thus dry and filtered air reaches the outlet nozzle N2.

3.2.2 Process in Adsorber 'B' (ADSR-2002) during 0 to 480 minute:

While above process is taking place at Adsorber 'A'(ADSR-2001), the Adsorber 'B' (ADSR-2002) will be under the process of regeneration. 'Regeneration' of Adsorber column is nothing but removing moisture particle from adsorber column which was saturated with moisture particle during 'Drying' process. The regeneration of Adsorber 'B' (ADSR-2002) is accomplished 5 consecutive sub-processes. Namely

1. Depressurization – Refer fig-1
2. Heating – Refer fig-2
3. Cooling – Refer fig-2
4. Purging – Refer fig-3
5. Re-pressurization – Refer fig-4

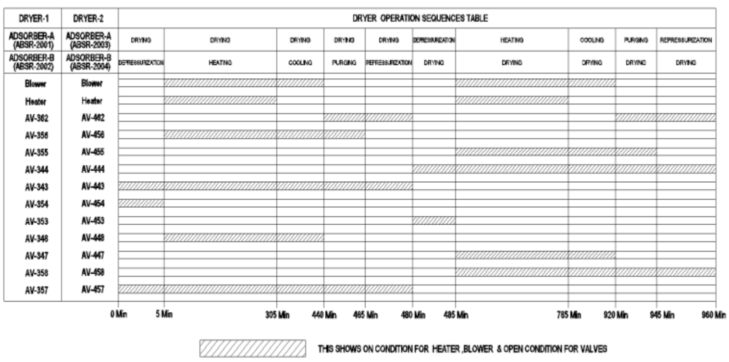
The de-pressurization valve (AV-354) opens & allows compressed air in Adsorber 'B'(ADSR-2002) to release through the silencer thereby the pressure in Adsorber 'B'(ADSR-2002) comes down to atmospheric pressure. This process extends up to 5 minute (Total duration 1 minute). This process could have been completed by even within 5 seconds if we open the valve (AV-356). But sudden exhaust of air through Adsorber would create high velocity inside the bed which will erode the silica gel. To avoid this erosion we first open the valve (AV-354) (which is 25NB compared with (AV-356) which is 100 NB) to slow down depressurization process up to 5 minute.

After 5 minute the depressurizing valve closed (AV-354), and the blower (7510-F-2001) and heater (HR-2001) will switch ON, then low pressure hot air passed to adsorber 'B' (ADSR-2002) through (AV-348) valve. Here the low pressure hot air will carry moisture from desiccants (silica gel) and leaves to atmosphere through (AV 356) valve. This process is called **'heating'** and is extended up to 305 min.(Total heating duration 300 minutes) After 'heating' process the heater (HR-2001) will switch off and blower (7510-F-2001) will continually run up to 440 min .(Total cooling duration 135 minutes) Here the desiccants will be cooled down to 45°C. This process called **cooling.**

After cooling process the re-pressurization valve (AV-362) opens and dry air is fed from out let of Dryer to Adsorber 'B' (ADSR-2002) and purges out to atmosphere, (outside CB at about EL.116M). Here the residual moisture content of desiccant is removed. This process extends up to 465 minutes.(Total purging duration 25 minutes) This process is called **purging.** After purging process AV 356 & AV348 valve are closed and adsorber 'B' (ADSR-2002) will be Re-pressured up to operating pressure. This process extends up to 480 minutes (Total re-pressurization duration 15 minutes) and is called **re-pressurization.**

After 480 minutes, the bed changeover will takes place automatically and Adsorber B (ADSR-2002) will be in Drying process and Adsorber A (ADSR-2001) will go in regeneration process. For a better understanding a pictorial representation of the same is provided below, the same is available in P&ID also.

3.3 DRYER OPERATION SEQUENCE TABLE:



SL.No	Function	7510-DR-01	7510-DR-02
1.	Bed Change Over Valves	AV-343, AV-344, AV-355, AV-356, AV-347, AV-348, AV-357, AV-358	AV-443, AV-444, AV-455, AV-456, AV-447, AV-448, AV-457, AV-458
2.	Purging Valve	AV-362	AV-462
3.	Depressurizations	AV-353, AV-354	AV-453, AV-454

IV. SOFTWARE DISCRIPTION

PROGRAMMABLE LOGIC CONTROLLER:

A Programmable logic controller is unit of hardware used to control and automate industrial processes. Programmable logic controllers (PLCs) are often defined as miniature industrial computers that contain hardware and software that is used to perform control functions. A PLC has three main aspects: the inputs and outputs and the control program. The inputs are connected to sensors that inform the PLC about the environment. The program uses a set of logical instructions that drives the outputs based on the inputs. The outputs are connected to the devices that need to be controlled.

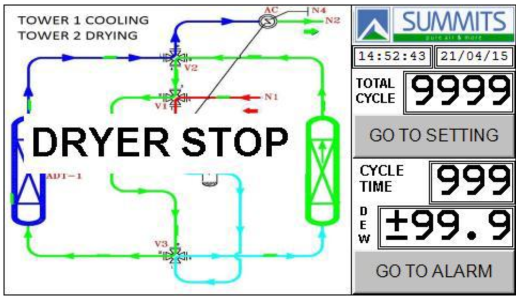
4.1 Advantages of PLC Control system:

- Flexible
- Faster Response Time
- Less and Simpler Wiring
- Solid State- No Moving Parts
- Modular design- Easy to Repair and Expand
- Allows for Diagnostics " Easy to troubleshoot"
- Less Expensive

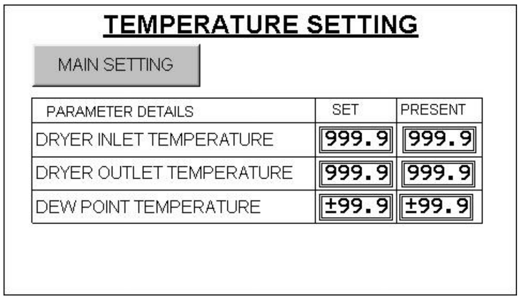
V RESULT

Thus the manual control process of the Desiccant Dryer is automated by developing the program with programmable Logic Controller Software.

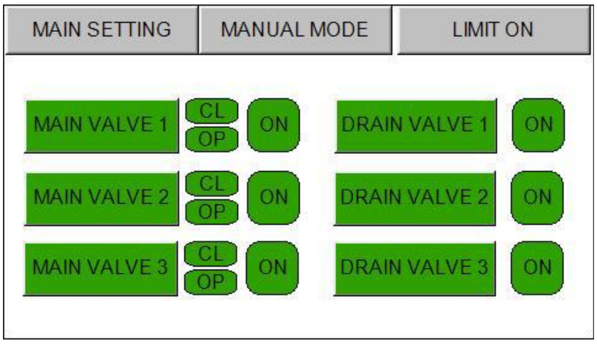
SCREEN 1:



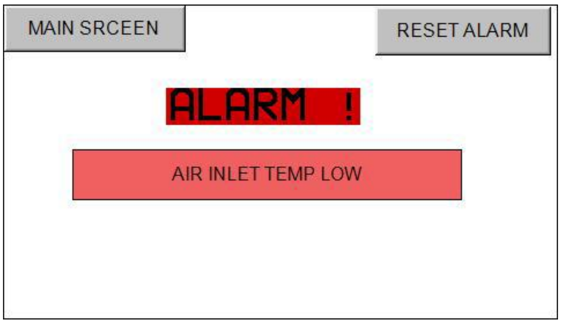
SCREEN 2:



SCREEN 3:



SCREEN 4:



VI CONCLUSION AND FUTURE SCOPE

The Automation of the Desiccant Dryer process has minimized the errors in monitoring process and it reduces the cost of the manual controller. It provides good controlling process and it increases the efficiency of the process.

The controlling process will be developed using Advanced controllers which stables the process quickly and increases the efficiency .

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