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Efficient Automation of Enhanced Process of Nitrogen Generation Plant Using Psa Principle by Using Plc & Scada

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Abstract:-- **In recent days most probably all industrial processes and parameters are controlled by using PLC & SCADA programming. The industrials like Oil refineries, Steel industries, Chemical plants, Shaving products plants. Nitrogen is a corrosive gas and it is usually used in Heat treatment plants. Also, it is used to dilute reagent gases, to increase the yield of some reactions, to decrease the fire or explosion. We generate nitrogen gas by using Pressure swing adsorption principle. Working on this principle depends upon the sequencing of Adsorbing and Desorbing of Carbon molecular sieves by the sequence of tower valves. These Valves are controlled by numerous cam timers, solenoid valves, Actuators and changeover Adsorbing & Desorbing of carbon molecular strainer is depending upon the Opening and closing of PSA valves. So finally Purity of nitrogen is depending upon the multiple cam timers, solenoid valves, Actuators and changeover valves. This is semi-automated. We are developing the PLC & SCADA Programming for this process. This paper describes by adding a Booster after Nitrogen surge vessel to increase pressure and placing the old electromechanical command with the PLC and SCADA. First, it displays the ladder logic that can be implemented to operate the Nitrogen generator plant. Secondly, it exhibits installation of PLC in the plant and factors to be regarded for its installation and operation.**

Index Terms - Booster compressor, Nitrogen, Psa Towers, PLC, SCADA.

INTRODUCTION

In our climatic air, this is having 78% nitrogen, 21% oxygen and 1% other impurities similar to carbon dioxide. Nitrogen plant is working on Pressure swing adsorption principle. Pressure swing adsorption principle means adsorbing and desorbing of oxygen by carbon molecular riddle and separates nitrogen from atmospheric air. In years ago the detachment of nitrogen from atmospheric air where designed using the Dynamic performance using air disunion unit. Dynamic optimization provides a utilitarian framework for the assessment of control performance limitations. It presents an edge near towards identifying the design characteristics of air separation plants that limit agility. The snags of this system design are specified and limit to control performance in retort to variations in electricity fare [1]. Non – cryogenic industrial gas processes comprise adsorption process, chemical process, polymeric membrane and iron transport membrane [2] technology. The comprehensive explanation of cryogenic processing with elucidation about compression cycles, pumped liquid cycles and low and elevated pressure cycles [3] . This paper highlights on PSA (PRESSURE SWING ADSORPTION). PSA can be most economical technique of onsite nitrogen generation for wide range of purity and flow requirements [4].

In this paper the automation is done utilizing industrial control system (ICS).This paper deals with Enhancement process of Nitrogen plant automation using PLC and SCADA. Programmable logic controller (PLC) is a digital computer used or automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement ride, or light fixtures. PLC is applied in many industries and machines. Programs to sway machine operation are routinely stored in battery-backed-up or non-volatile memory. The term SCADA habitually refers to centralized systems which monitor and control entire sites, or complexes of systems unroll out over large areas. For example, a PLC may dominance the flow of cooling water through part of an industrial process, but the SCADA system may allow operators to change the set points for the flow, and enable alarm conditions, such as loss of flow and high temperature, to be displayed and recorded

II. PRINCIPLE OF OPERATION

Plant has two tanks of similar capacity constituting with different solenoid valves and other associated paraphernalia. When the pressure in air receiver tank exceeds 7 kg/cm2, it admits to first tank through appropriate valves. Now, oxygen and other impurities are absorbed by the CMS (Carbon Molecular Sieve) and nitrogen is spilt. When first tank works

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for 40 seconds the second one regenerates then within another two seconds both tank equalize the pressure nitrogen generated in first tank pass to the storage tank, through appropriate solenoid valves and surge vessel by releasing the impurities. Then the operation is repeated in the second tank. Both tanks operate simultaneously one after another with an interval of 10 seconds. So that process is continued and Nitrogen storage tank is filled as required. A nitrogen storage tank is installed after nitrogen surge vessel for depot of nitrogen gas at pressure of 5.0 kg/cm2g. And there is an oxygen analyzer and a three way valve in middle of the nitrogen storage tank and surge vessel. The oxygen analyzer will examine the amount of oxygen in the gas. If oxygen content exceeds 0.7% the three way valve will direct that gas to air. Else it is stored in the nitrogen storage tank. Nitrogen generates are based on well proven technology using carbon molecule sieves (CMS) evolved and supplied by Carbotech-Germany. CMS is an absorbent having infinite number of small pores.Nitrogen generates are based on well proven technology using carbon molecule sieves (CMS) expand and supplied by Carbotech- Germany. CMS is an absorbent having infinite number of small pores.An oxygen molecule having a smaller diameter than a Nitrogen molecule .Therefore, the nitrogen is pull off to a higher degree while almost all the oxygen is adsorbed. So that process is continued and Nitrogen storage tank is filled as required.

Fig.1.Carbon Molecular Sieve

Pressure Swing Adsorption (PSA Nitrogen) process comprises of 2 vessels pervade with layer of activated alumina and Carbon Molecular Sieves (CMS). Firstly air is compressed to a pressure of 7 kg/cm2. This compressed air is passed through the heat exchanger to lower its temperature. This Pre-filtered compressed air is passed through one CMS filled tower. At the bottom of the tower, activated alumina is placed which has the tendency of absorbing moisture from the air. After this, compressed air will come in contact with bed of Carbonmolecular sifter (CMS) where oxygen, carbon dioxide and moisture are adsorbed [5]. The unadsorbed gas which is chiefly nitrogen comes out and goes into the nitrogen surge vessel. Upon saturation of the CMS in the vessel, the process switches nitrogen generation to the other vessel, while allowing the saturated bed to undergo regeneration by depressurization to atmospheric pressure. The waste gas (oxygen, carbon dioxide, etc.) is discharged into atmosphere. The adsorbers keep switching automatically nearly every one minute by a sequence timer and nitrogen with the purity of 99.8 % is continuously produced and goes to the nitrogen surge tank.

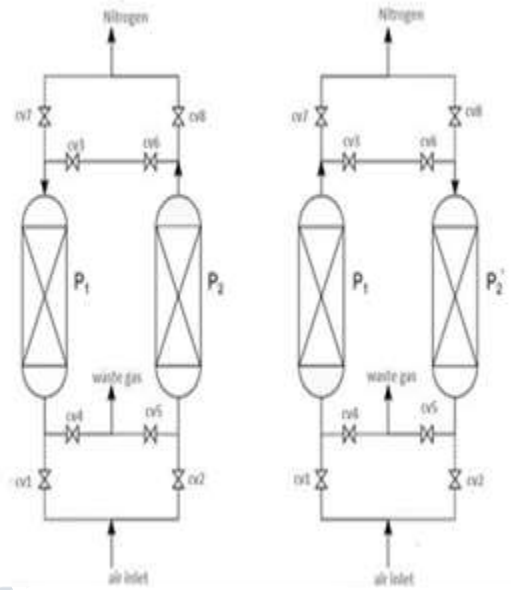

Fig 2. PSA type Nitrogen generator adsorption occurring in P2

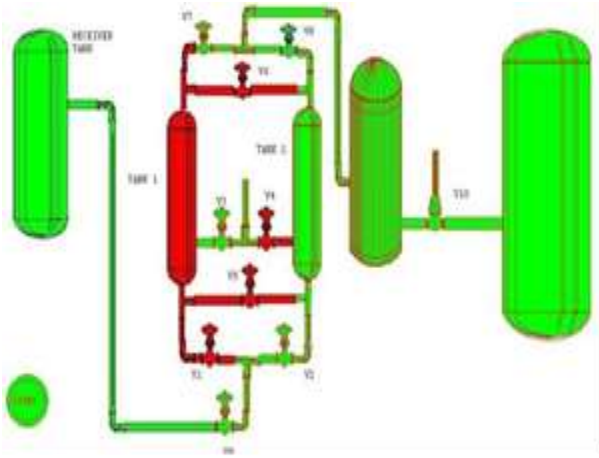

Fig3. PSA type Nitrogen generator adsorption occurring in P1

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III. BLOCK DIAGRAM

The block diagram of Nitrogen Plant is shown in figure-4 consisting of following:

Air compressor which sucks air from atmosphere to initiate the process. The pressure inside the compressor should be between 6-8 kg/cm2.Air receiver tank which stores the pressurized gas and also known as air buffer tank. The pressure inside the air receiver tank will be between 6-8 kg/cm2.Tower1 & Tower 2 is the main part of the system, having similar capacity. Where each tower consists adsorption vessel packed with Carbon Molecular Sieves (CMS). At high pressures, Oxygen and other trace gases are absorbed by the CMS, allowing nitrogen to pass through. Since, oxygen molecules have smaller diameter than nitrogen molecules, they enter into the pores. Surge vessel which stores the nitrogen generated and also provide better performance. Booster is used to increases the pressure and improves the productivity. By using Oxygen analyzer purity of the product is being checked continuously. Nitrogen storage tank is mainly used for the storage of purified nitrogen.

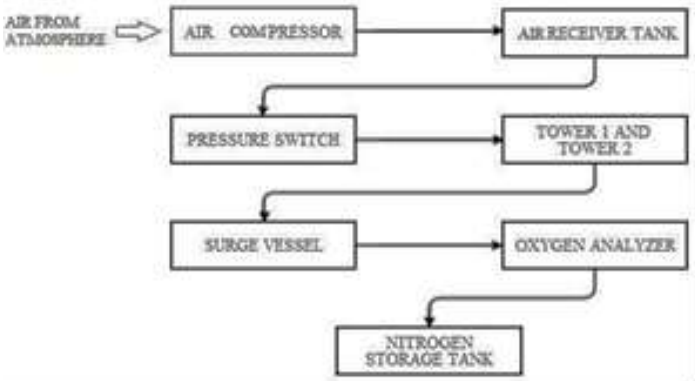

Fig.4 Block diagram of nitrogen plant

IV. WORKING

Plant has 2 tanks of homogenous capacity constitute with different valves and associated paraphernalia. When pressure in the air receiver tank exceeds 7 kg/cm2 valve v9 will open. It admits air to tanks through valves. Figure 2 shows the complete circuit diagram of nitrogen plant. The PSA process cycle consists of two key mechanisms:1. Pressurization/ adsorption 2. Depressurization/desorption. In the first cycle tank 1 will be in adsorbing state. Valve V1, V4 and V7 will be open on first cycle. Now oxygen and other impurities are absorbed by the CMS and Nitrogen is spilt. And Nitrogen generated in the first tank passed to the storage tank, through valve V7 and surge vessel. When first tank work for 40 seconds, second one is regenerated. Within another 10 seconds both tank equalize the pressure. The valve V5 and V6 will open. And will regularize the pressure in two tanks. After 10 second standardize second cycle will start. The tank 2 will goes to adsorbing state. And valve V2, V3 and V8 will open. Then the operation is repeated in the second tank while first tank goes under regeneration where adsorbed gases are desorbed to atmosphere. After that there is a balance step. It will take 10 seconds. This operation is alternatively repeated in both tanks

A nitrogen storage tank is installed after nitrogen surge vessel for storage of nitrogen gas at pressure of 5.0 kg/cm2g. And there is an oxygen analyzer and a three way valve in between the nitrogen storage tank and surge vessel. The oxygen analyzer will inspect the amount of oxygen in the gas. If oxygen content exceeds 0.7% the three way valve will direct that gas to air. Else it is stored in the nitrogen storage tank.
Flow-chart diagrammatic is been shown in the below Fig. This flow-chart gives the absolute idea for the working principle of the automation. Initially process starts from the air receiver tank. When pressure in the air receiver tank exceeds 7kg/cm2 the valve V9 opens and it starts operation. The PSA [5] process cycle consists of 2 key mechanisms:1.Adsorption 2.Desorption

When first tank 1 works for 40 seconds the second one regenerates. At this time adsorption take place for tank 1, and valves V1, V4 and V7 were open. Concurrently all other valves gets closed for the process to take place. Nitrogen generated in first tank pass to the surge vessel for a temporary storage. Within another 10s both tank equalize the pressure with valves V5 and V6 were open. Next 40s adsorption take place for tank 2 and at this time first tank regenerated and the impurities gets liberated through the silencer. Nitrogen generated in tank 2 reaches the storage tank through valves V2, V3 and V8.Next 10s both tank equalize the pressure similarly as above. This operation alternatively repeated in both tanks. After the process of storing in the surge vessel it gets transferred to the main storage tank. But in between these surge vessel and storage tank there is a special device known as the oxygen analyzer for analysis of oxygen content in the purified product. When the amount of oxygen is less than 0.7%, it reaches the storage tank. Otherwise it is vented back to air.Then from storage tank it is used for further uses.

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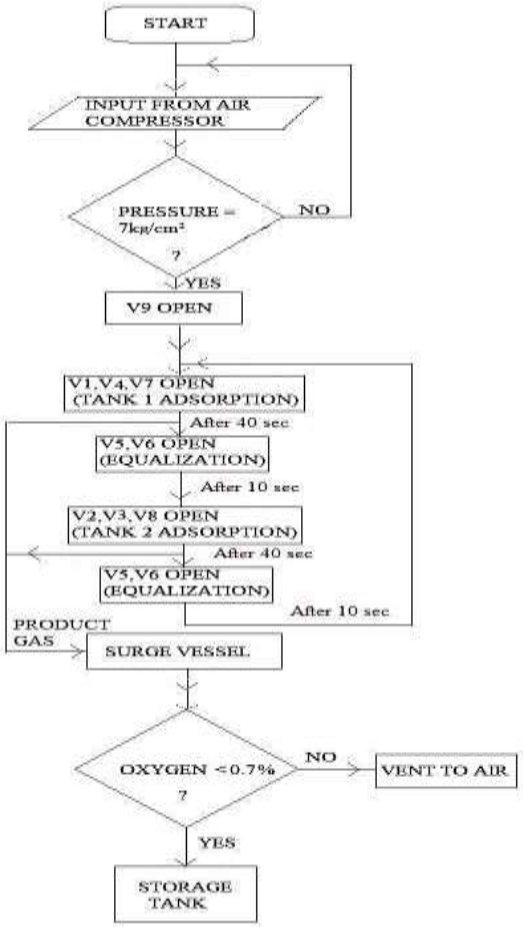

Fig.5 Flow chart of enhancement of nitrogen plant

V. SCADA IMPLEMENTATION

The SCADA system was delineate with a software Package that has helped to ensure future upgrade Capability and compatibility. The controlling is being done using mainly10 types of valves, also consist of receiver tank, surge vessel, and main storage tank.In the given figure, the green color indicate the flow of nitrogen and the red color indicates the waste gas.

VI. CONCLUSION

As per this paper "Enhanced Nitrogen plant automation using PLC & SCADA" highlights the process of manufacture and quantity control with the automation process in the industry.

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REFERENCES

[1] Design for Dynamic Performance: Application to an Air Separation Unit, Yanan Cao, Christopher L.E. Swartz and Michael Baldea

[2] Cryogenic air separation Chapter-2,UNIVERSITY OF PRETORIA.

[3] PSA Nitrogen generating system , MAYEKAWA marine division, ecology and energy dept.

[4] A review of air separation technologies and their integration with energy conversion processes, A.R. Smith, J. Klosek

[5] Stability analysis of a pressure swing adsorption process, C. Bechaud, S. Melen, D. Lasseux, M. Quintard, C. H. Bruneau