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Automation of Media Filter

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ABSTRACT: *Media Filters are primarily used to separate suspended particles, river silt and other impurities from the water. It is used in Irrigation and in Sewage water treatment. It has a robust fabrication with quality and precision. Media Filters provide a fixed material on which a thin biological film is established by organisms in colonies growing on the surface of the media as wastewater passes through the bed. These filters are used for fine sifting the water. These filters are capable of handling high volume of flow up to 60,000 lit per hour. However they can be connected with help of header assemblies for more volume of flow. So the need arises to control their operation automatically with the help of advance in technology. Backwash operation is manual for the filter. We propose to use Pressure transmitter, electrically operated valves, Microcontroller and timer for the operation for backwash operation. Pressure transmitters are used for two pressure input at inlet and outlet. By setting a microcontroller we can measure ΔP. If the value of ΔP is larger than specified value of designer, then a sequence of valves operate backwash mechanism. In backwashing of a filter the flow of water is reversed in opposite direction.*

Keywords*— Media Filter Backwash, Irrigation, Automation, Microcontroller.*

□. INTRODUCTION

Media filters uses media in the form of crushed granite or quartz silica sand as media. Water is flown into the filter and made to undergo a torturous route through the media. The contaminants are trapped into the media by the principle of adsorption or development of **Van der waal forces of attraction.** The filter is in the form of a pressure vessel with internal pressure of **2 kg/cm²** in normal condition. The impurities like river silt, biological waste tend to block the filter. In the course of our research we have visited number of users and we have learnt the problems in media filter while operating it manually. Untimely blockage of filter causes extreme results like bursting of filter or development of back pressure on pump which supplies water. Sometimes the piping between filter and pump is damaged which causes great deal of discomfort to the end user at site. Taking cue on the use of technology we hope to provide solution.

In filter design water is brought from the top of a shell through a **"header"** which distributes the water evenly. The filter "media" start with fine sand on the top and then graduating coarser sand in a number of layers followed by gravel on the bottom, in gradually larger sizes. The top sand physically removes particles from the water. The job of the subsequent layers is to support the finer layer above and provide efficient drainage. Quartz Silica Sand is used as medium of filtration. A bed of sand up to height approximately 400 mm is formed inside the shell and water is allowed to flow through it. Then the water is collected in the lower part of the filter which is fed to the system. This system is easy to backwash [1].

II. BACKWASH MECHANISM

In the normal operation of filter water impinges a deflector and spreads evenly on the media bed which then is made to pass from plastic mushrooms. To clean the filter opposite of this system is carried out. In backwash mechanism water enters from the outlet follows the reverse of the flow.

Backwashing of granular media filters involves several steps. First, the filter is taken off line and the water is drained to a level that is above the surface of the filter bed. Next, compressed air is pushed up through the filter material causing the filter bed to expand breaking up the compacted filter bed and forcing the accumulated particles into suspension. After the air scour cycle, clean backwash water is forced upwards through the filter bed continuing the filter bed expansion and carrying the particles in suspension into backwash troughs suspended above the filter surface. In some applications, air and water streams are simultaneously pushed upwards through the granular media followed by a rinse water wash [2].

Backwashing continues for a fixed time, or until the turbidity of the backwash water is below an established value. At the end of the backwash cycle, the upward flow of water is terminated and the filter bed settles by gravity into its initial configuration. Water to be filtered is then supplied to the filter surface until the filter clogs and the backwash cycle needs to be repeated. Spent backwash water is either discharged without treatment to a sanitary sewer system or is treated and recycled within the plant.

We designed the backwash mechanism of media filter by giving the media filter two inlets and two outlets. A bypass connection at inlet is provided [3]. All the four connections receive a signal by a Microcontroller and are controlled by electrically operated motorized valves. The connections have flanged ends with sizes of two inches on each end. These valves fit on the inlet and backwash inlet.

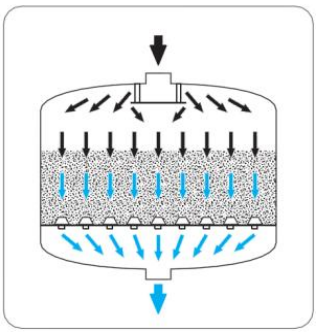

Fig.1 Filtering process

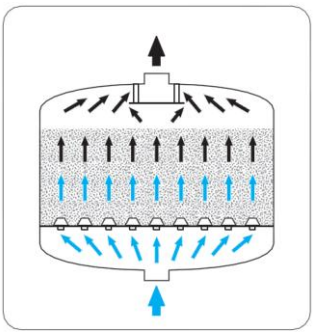

Fig.2 Backwashing process

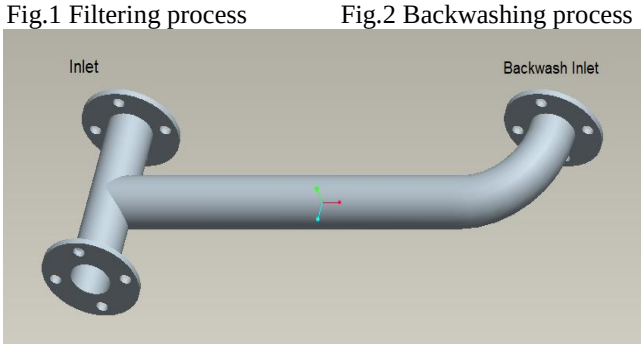

Fig.3 Backwash Mechanism

At the time of backwash the valves connecting inlet is closed and simultaneously the valve at backwash inlet is opened and the flow of water is diverted to backwash port [2].

III. AUTOMATION

Concept of Automation

To measure inlet pressure P1 and outlet pressure P2 with the help of pressure transducers. Output of pressure transducer is fed to microcontroller, which calculates the difference in the pressure. According to guidelines of Bureau of Indian Standard IS 14606:2009 we are required to calculate and monitor the difference in the pressure at inlet and outlet. Manufacturer has to specify the limiting value of ΔP. A key-board will be used to set the value for ΔP which will change from one manufacturer to the other. When ΔP is greater than the specified value controller will operate the valves, which will start the backwashing process. A timer will set the value for backwash. Input to the timer is given by the user which is variable and changes for requirements of end users.

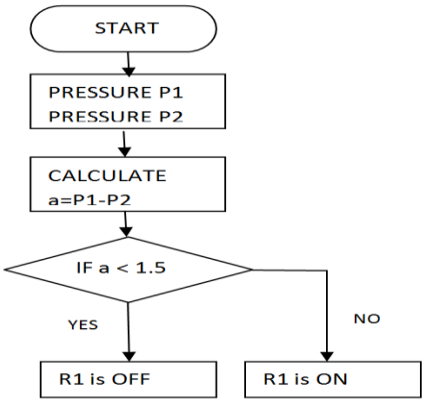

Fig.4 Flowchart of Processor

The circuit is operated on relay (R1). Pressure P1 and P2 are 2 inputs at the initiation of the programme. After that difference in the pressure is calculated and stored as 'a'. In the normal working condition of the filter, valves at inlet and outlet are open. This condition is set when relay R1 is in the OFF condition. As the difference in the pressure ΔP reaches the limiting value; in this case 1.5, relay is energized and becomes ON.
Components of Automation:-

1. Microcontroller

We are going to automate the media filter with help of microcontroller. The microcontroller is integration of a microprocessor with memory input/output interfaces and other peripherals such as timers, on a single chip. The general microcontroller has pins, grouped into units called input/output port. Usually such port has eight lines in order to be able to transfer an 8-bit word out data. We are using ATMEL 89C51 Microcontroller for automation of the media filter. AT89C51 is an 8-bit microcontroller and belongs to Atmel's 8051 family. ATMEL 89C51 has 4KB of Flash programmable and erasable read only memory (PEROM) and 128 bytes of RAM. It can be erased and program to a maximum of 1000 times. All four ports in the AT89C51 bidirectional. In 40 pin AT89C51, there are four ports designated as P_1, P_2, P_3 and P_0. All these ports are 8-bit bi-directional ports, *i.e.*, they can be used as both input and output ports. Except P_0 which needs external pull-ups, rest of the ports have internal pull-ups. When 1s are written to these port pins, they are pulled high by the internal pull-ups and can be used as inputs. These ports are also bit addressable and so their bits can also be accessed individually. Port P_0 and P_2 are also used to provide low byte and high byte addresses, respectively, when connected to an external memory. Port 3 has multiplexed pins for special functions like serial commu-nication, hardware interrupts, timer inputs and read/write operation from external memory. AT89C51 has an inbuilt UART for serial communication. It can be programmed to operate at different baud rates. Including two timers & hardware interrupts, it has a total of six interrupts [3].

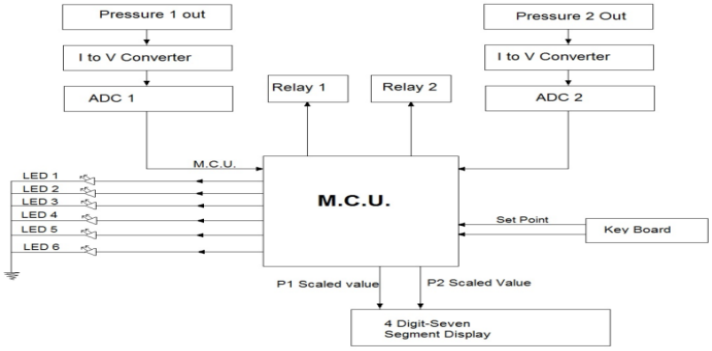

Fig. 6 Hardware Diagram of Microcontroller circuit

2. Pressure Transmitter

There are various kinds of pressure transmitters like Diaphragm type, piezoresistive type and capacitance type of pressure transmitters used in industries. We are using JUMO MIDAS S05 Type 401010 pressure transmitter. This pressure transmitter is used between pressure ranges from 0-25 Bar at ambient temperature. It uses piezoresistive Silicon Sensor for transmitting the pressure. It is safe for handling and also

economical. It has sturdy design which is strong. The JUMO MIDAS S05 pressure transmitter is available with relative pressure and absolute pressure measuring ranges. The fully welded measuring system (without seals) made of high-grade stainless steel allows this device to be used in almost all media, even in harsh conditions. The structure ensures optimum protection against process medium leakage. The used silicon sensor is resistant to extreme overloading and is capable of handling millions of pressure cycles. The installation of the measuring instrument requires little work and the electrical installation is simple. The modular structure means that it can be used universally in almost any application. Output current of the JUMO MIDAS S05 pressure transmitter is 4-20 Amps [4].

3. Electrically Operated Valves

We are using an electrically operated ball valve. We have used a 12 Volt DC motor as actuator. The motor rotates with speed of 5000 rpm which is reduced in four stage epicyclic gear box to the required speed. The output connections of the valve are three connections forward, rear and neutral. The motor is completely reversible. A specifically machined cam is used inside the motor. Cam is mounted on the shaft connecting the actuator with the rotating ball. The motion of the cam is restricted between two limit switches for opening and closing of valve. A PVC casing is provided on the assembly.

Fig. 5 Micontroller Panel

IV. CONCLUSION

Using microcontroller, pressure transmitter and electrically operated valves we can successfully automated the media filter. The same controller can be used for different sizes of media filter ranging from 10 m^3/hr to 50 m^3/hr. The cost of the project can be maintained up to a limit of 30000 Rs. which can provide a complete reliable and efficient solution for user of the media filter.

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