Diala , Jour , Volume , 32 , 2009

DESIGN OF AN ELECTRONIC CONTROL SYSTEM ON PRESSURE IN OIL INDUSTRIES USING ELECTRONIC PROPORTIONAL CONTROLLER.

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ABSTRACT

There is an important need in the industrial applications to have a control system by which we can control the flow rate ,pressure ,and differential pressure of a fluid especially in the Industrial applications.
There are some methods used to control the above quantities.
For example the computer control method ,the programmable logic controller method .
These methods have advantages and disadvantages ,where their advantages are having high speed control and accuracy , while their disadvantages are having high cost and sometimes are not available.
This paper presents a new and a low cost way to control on the (flow rate ,pressure ,and differential pressure) in oil industries.
In this paper a proportional controller had been designed ,where this controller consisted of two parts the first is responsible for the required set point ,and the second for comparing the received signals coming from the transducers with required set point signals.

الخلاصة

هناك حاجة ماسة في التطبيقات الصناعية إلى وجود نظام سيطرة بواسطته نستطيع أن نسيطر على معدل الجريان ، الضغط ، وفرق الضغط لمائع و خاصة في التطبيقات الصناعية.
توجد بعض الطرق للسيطرة على هذه الكميات ،و منها السيطرة بنظام الحاسوب ،والسيطرة بنظام المسيطر المبرمج ، ولكل من هذه الطرق فوائد و مضار.
فوائد هاتين الطريقتين السرعة و الدقة العالية ، أما مضارها فهي كلفتها العالية و عدم توفرها في أسواقنا المحلية.
في هذا البحث تم تصميم مسيطر تناسبي يتألف من جزأين الأول يقوم بتحديد الكمية المطلوبة ،أما الثاني فيقوم بمقارنة باستلام الكمية الحالية من موقع العمل و مقارنتها مع الكمية المحددة.

INTRODUCTION

Every day we face the quantities (flow rate , Pressure ,and differential pressure of a fluid .
These quantities called physical quantities that we face in most oil industrial applications.
Sometimes we need dealing with the pressure of a tank containing a fluid ,or we need dealing with a temperature of a heating station.
To do so we must know that there are electronic devices called transmitters that transform those physical quantities into direct currents with the range (4-20)mA DC,where they are called (P/I) converters.
In order to build a closed control system we also need another device that transforms the direct current into the required pressure called current to pressure converter (I/P)and its function is to convert (4-20)mA DC into the required physical quantity .
There is a coordination between these converters and the designed proportional controller **[1]**.
In this paper we presented a closed loop system that consisted of three main parts :
1- The proportional controller and is called the main coordinator of the controlled operation.+
2- A pressure transmitter that gives the actual vale of the measured quantity of the pressure.
3- A current to pressure converter (I/P) .
The measurement of flow is influenced by flow rate .
Flow rate ,by itself, is commonly measured .
The quantity of flow can be measured by using flow rate along with a mass quantities.
Flow rate instrumentation is used to determine the amount of material move past a given point at a particular instant.
Volumetric flow rate instrument are used to determine the volume of a material that flows during a time period.
For example flow rate of a liquid can be determined from the velocity and volumetric flow rate of a pipe according to the following equation.

$$\mathbf{Q=VA}$$

Where :
Q is the volumetric flow rate in a pipe.
V is the velocity of the flow in a pipe.
A is the cross –sectional area of a pipe.

THE CONFIGURATION OF AN OIL INDUSTRIAL SYSTEM

This paper presented another design to replace the two previous methods used to control the pressure of an oil industrial process **[2],[3]**.
The configuration of the required closed loop system is shown in figure (1).

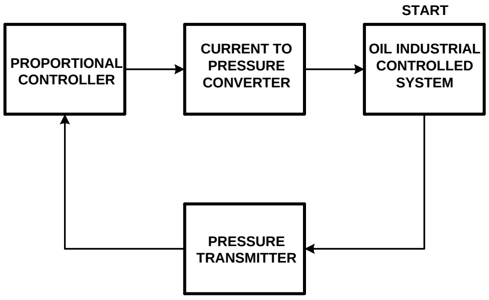

Figure (1) The configuration of an oil industrial system.

DESCRIPTION OF THE CONFIGURED SYSTEM PARTS.

1- THE PRESSURE TRANSMITTER.

The block diagram of the pressure transmitter is shown in figure (2).
An increase in pressure on the process diaphragm is transmitted through the fill-fluid to the ceramic diaphragm in the capacitance sensor.
The pressure increase causes the diaphragm to bulge, changing the distance between the diaphragm and the reference plate.
The gap at the capacitor (C+) increases and the gap at the capacitor (C-) decreases **[4],[5]**.
This causes a decrease in the positive (C+) capacitance and an increase in the negative (C-) capacitance because these capacitance changes are additive ,the ratio of (C-) to (C+) changes in proportion to the sum of the changes in the two capacitances.
The change in capacitance causes a change frequency in the oscillator circuit which feeds the logic circuit.
Increased output from the logic circuit is converted to a dc voltage and amplified by the gain and summation circuit.
The signal from the gain and summation circuit is applied to the output current regulator through the zero and span circuit.
The output current regulator which is controlled by the signal from the zero and span circuit , produces an increase in transmitter output current which is proportional to the increase in process pressure.

Temperature compensation is provided by a compensation circuit in the transmitter electronics. The compensation circuit receives a signal proportional to temperature from a thermistor located in the Primary.

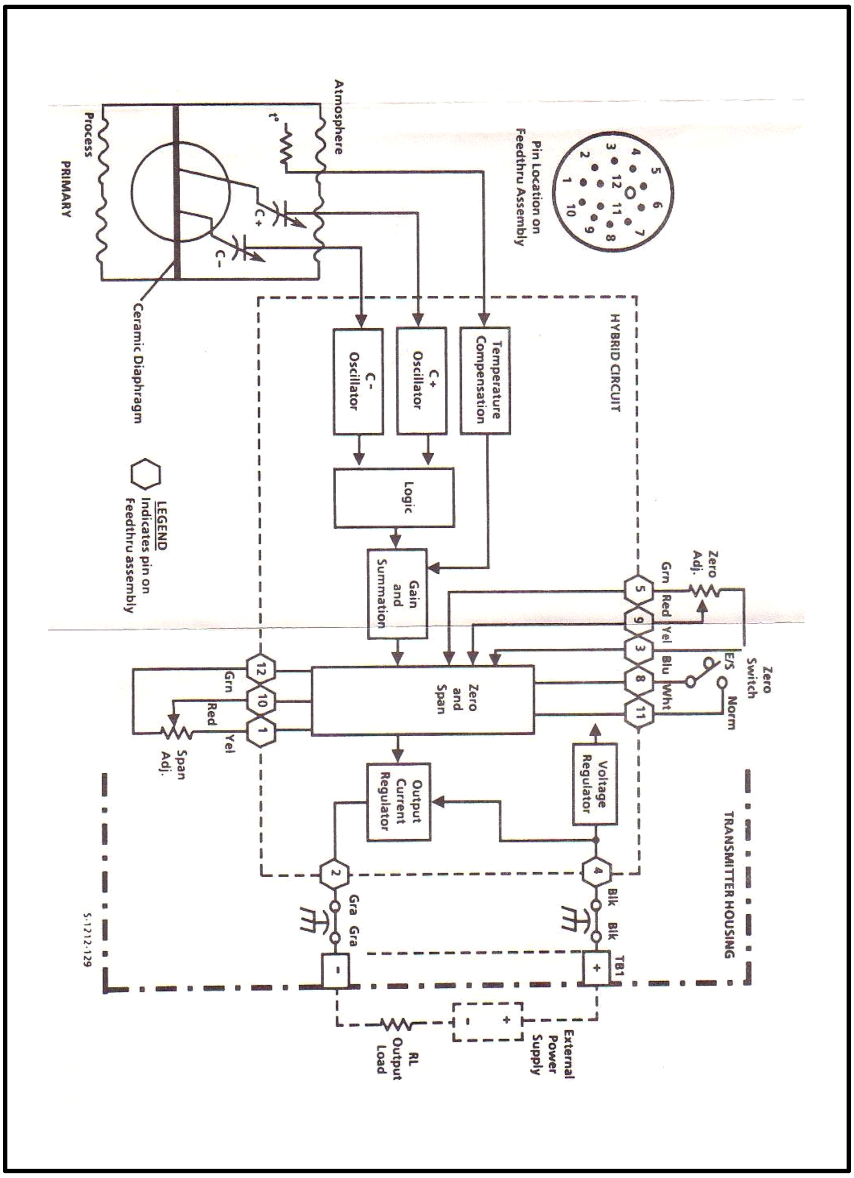

Figure (2) the block diagram of the pressure transmitter.

2-THE CURRENT TO PRESSURE CONVERTER

In order to understand the process operation of this converter , it is similar in fact to the process operation of the pressure to current converter.

This converter when is supplied with a dc current (4 mA) it gives us a zero pressure.

When supplied with a dc (20 mA) the converter gives us a maximum output pressure called span pressure **[6],[7]**.

3-THE OIL CONTROLLED DESIGNED SYSTEM
The oil controlled system is an oil tank with a required level.
In this paper we have designed a proportional card for controlling the required level of oil automatically.

THE EXPERIMENTAL PROCEDURE AND THE REQUIRED SIMULATION

1- VOLTAGE-CONTROLLED CURRENT SOURCE AND SIMULATION**.**

We have designed the electronic circuit shown in figure (3) in order to convert the voltage into the required current.
Since the pressure transmitter is no a available hence it was replaced by the circuit below because there is a compatibility between the pressure transmitter and it.

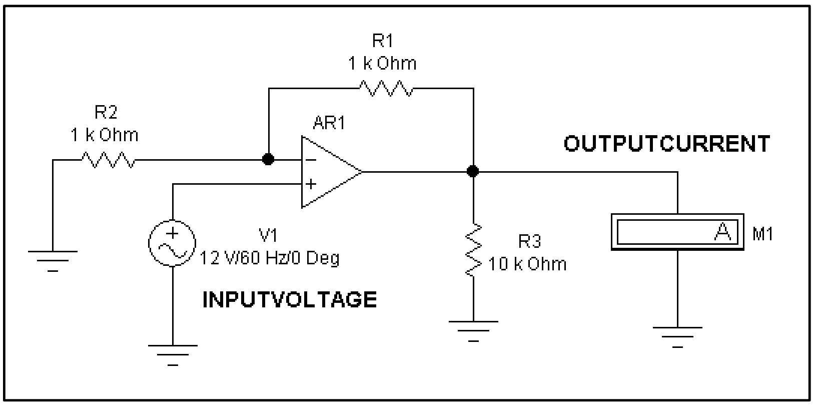

Figure (3) voltage to current converter.

Figure (3) has been simulated as shown in figure (4).
The magnitude of the current output of a voltage- controlled current source is dependent on the voltage applied at the input terminal (show figure 3). The two are related by a parameter called transconductance (G), which is the ratio of the output current to the input voltage. It is measured in mhos (also known as seimens) and can have any value from mmhos to kmhos **[8]**.

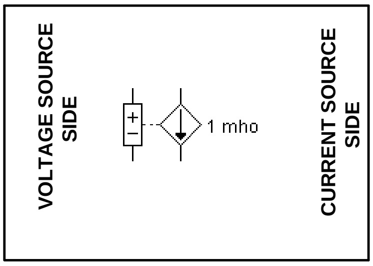

Figure (4)simulated voltage to current converter.

We need a pressure transmitter for our design we have simulated it as shown in figure (5).

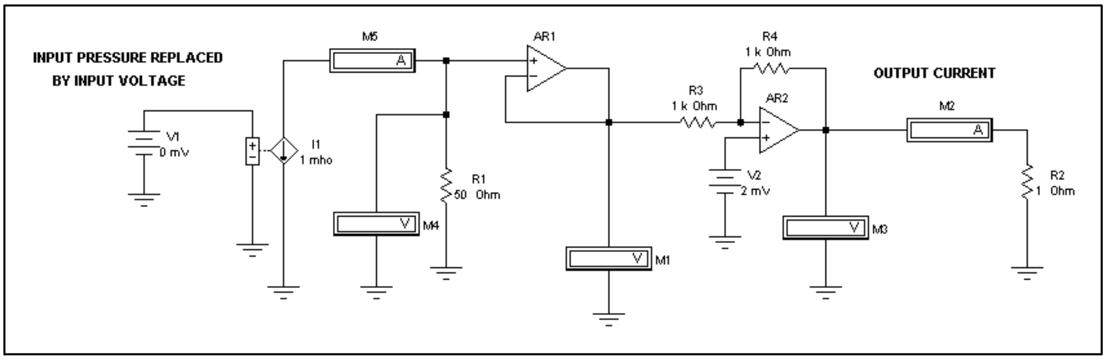

Figure (5) simulation of the pressure transmitter.

Table (1) shows us the relationship between the input voltage and the output current ,where the input voltage represented the input pressure of the transmitter.

Table (1) the relationship between the input voltage and the output current of the circuit in figure (5).

INPUT VOLTAGE(mV)	**OUTPUT CURRENT(mA)**
0	4
50	6.5
100	9
150	11.5
200	14
250	16.5
300	19

350	21.5
400	24
450	26
500	29

2-CURRENT –CONTROLLED VOLTAGE SOURCE AND SIMULATION.

We have designed the electronic circuit shown in figure (6) in order to convert the current into the required voltage.

Since the current to pressure converter is no a available hence it was replaced by the circuit below because there is a compatibility between them.

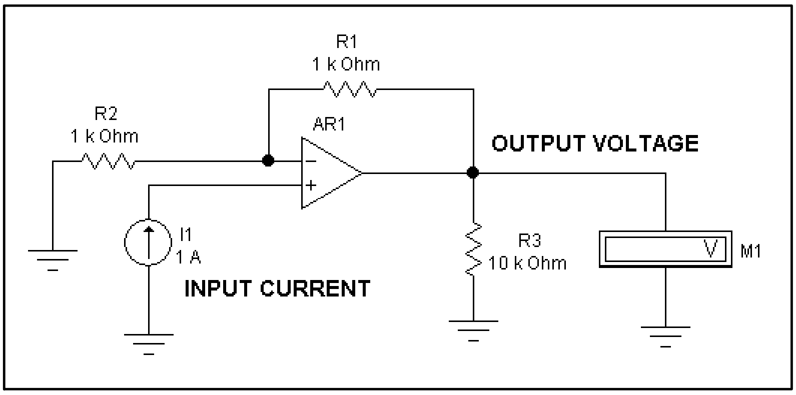

Figure (6) voltage to current converter.

Figure (6) has been simulated as shown in figure (7).

The magnitude of the voltage output of a current-controlled voltage source is dependent on the current through the input terminals (show figure 4). The two are related by a parameter called transresistance (H), which is the ratio of the output voltage to the input current. It can have any value from mW to kW.

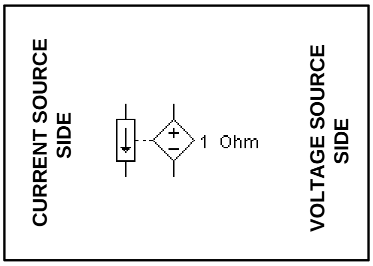

Figure (7)simulated voltage to current converter.

We need a current to pressure converter for our design we have simulated it as shown in figure (8).

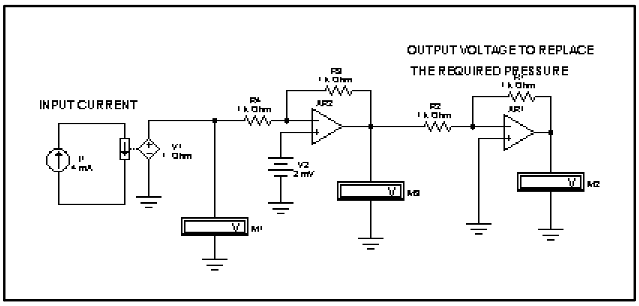

Figure (8) simulation of the current to pressure converter.

Table (2) shows us the relationship between the input current and the output voltage ,where the output voltage represented the output pressure of the current to pressure converter.

Table (2) the relationship between the input current and the output voltage of the circuit in figure (8).

INPUT CURRENT(mA)	**OUTPUT VOLTAGE(mV)**
4	0
6	2
8	4
10	6
12	8
14	10
16	12

18	14
20	16
22	18
24	20

4-THE PROPORTIONAL CONTROLLER CARD

This card is shown in figure (9).
The card consists of two main parts:
1- The set point part which is responsible for determining the required value of the pressure of the controlled oil industrial system.
2- The pressure to current converter part which is responsible for converting the required pressure into the equivalent value in current to processed .
Multiple meters have been used to measure currents and voltages in different positions as required for checking **[9], [10]**.

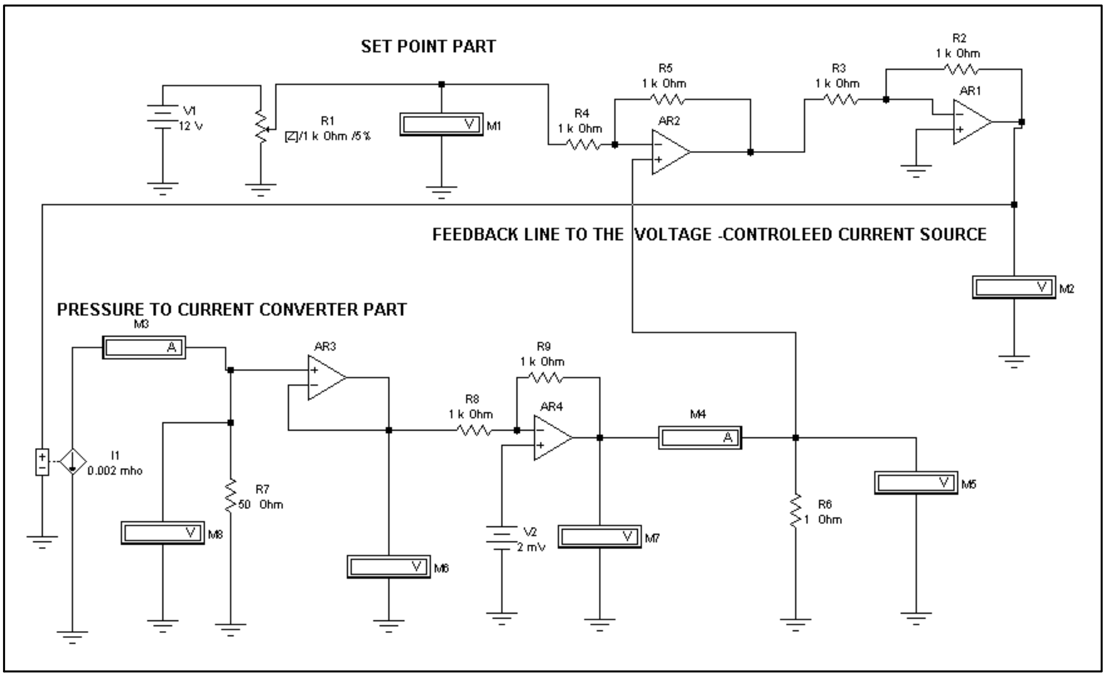

Figure (9) the designed proportional controller card.

RESULTS AND DISCUSSION

Table (3) shows the given data from the meter M3 and the obtained current from the meter M1(M1 is the set point ,M3 is the transmitted current).
Increasing the set point value means increasing in the demand of the pressure of the controlled oil system theoretically.
The obtained results gave us the same expected results,i.e,the table showed us increasing the set points of the proportional controller card means that more receiving in current by the pressure transmitter.

Table (3) data relationship between the required set point and the current received by the pressure transmitter.

SET POINT VOLTAGE (VOLTS) M1	TRANSMITTED DC CURRENT(mA) M3
1	1.653
1.5	2.487
2	3.320
2.5	4.153
3	4.987
3.5	5.820
4	6.653
4.5	7.487
5	8.320
5.5	9.153
6	9.990
6.5	10.820
7	11.650
7.5	12.490
8	13.320
8.5	14.150
9	14.990
9.5	15.820
10	16.650
10.5	17.490
11	18.320
11.5	19.150

12	20

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