cleaning the vanes. This also leads to better cooling and combustion. Through the improvements made to the basic elements of the engine (power turbine blades, compressor blades, regenerative recuperator and others) it has been achieved that the operation of these types of engines is superior to thermal engines used in extreme navigation areas (tropical and equatorial).

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ASPECTS OF CONTROLS PRINCIPLES IN SHIPS

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Following initial build, after refit or maintenance, it will usually be necessary to carry out tests of controlled systems, the control systems themselves and instruments within the control systems. The checks will usually be carried out by injecting input disturbances and watching how the output follows. Alternatively, load changes can be applied to disturb the system under control and the recovery curves observed. For example, the control of diesel generators can be checked by starting large equipment such as air-conditioning plant and observing the response of the engine speed and, at the switchboard, how well the voltage control systems function. In control engineering, it is frequently concerned with the graphical representation of time-varying signals.

Keywords: control, regulatory, machinery, signal

АНАЛИЗ ПРИНЦИПОВ УПРАВЛЕНИЯ НА СУДАХ

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После первоначальной сборки, после ремонта или технического обслуживания обычно необходимо провести испытания управляемых систем, самих систем управления и приборов в составе систем управления. Проверки обычно осуществляются путем введения входных возмущений и наблюдения за выходом. В качестве альтернативы можно использовать изменения нагрузки, чтобы нарушить равновесие управляемой системы и наблюдать кривые восстановления. Например, управление дизель-генераторами можно проверить, запустив энергоемкое оборудование, такое как установка кондиционирования воздуха, и наблюдая за реакцией скорости двигателя, а на распределительном щите — затем, насколько хорошо работают системы контроля напряжения. В технике управления это часто связано с графическим представлением изменяющихся во времени сигналов.

Ключевые слова: управление, регулирование, техника, сигнал.

1 System performance

When considering system performance there are 3 main criteria that must be considered:

a) By how much will the output change when a load is applied to the system, example: at what new value will the output settle down?

b) How will the system behave whilst the enforced change of the output is taking place and how long will the change take?

c) How will the system respond to a regular periodic disturbance?

Some of these results can only be established by trial, but others can be determined mathematically. Any mathematics introduced into these notes is only to assist in the understanding of the solution to the above question. The basic closed loop can be represented in an enhanced block diagram form. [1]

It can be seen that the system can be divided quite neatly into 4 basic blocks. The performance of each block will affect system performance.

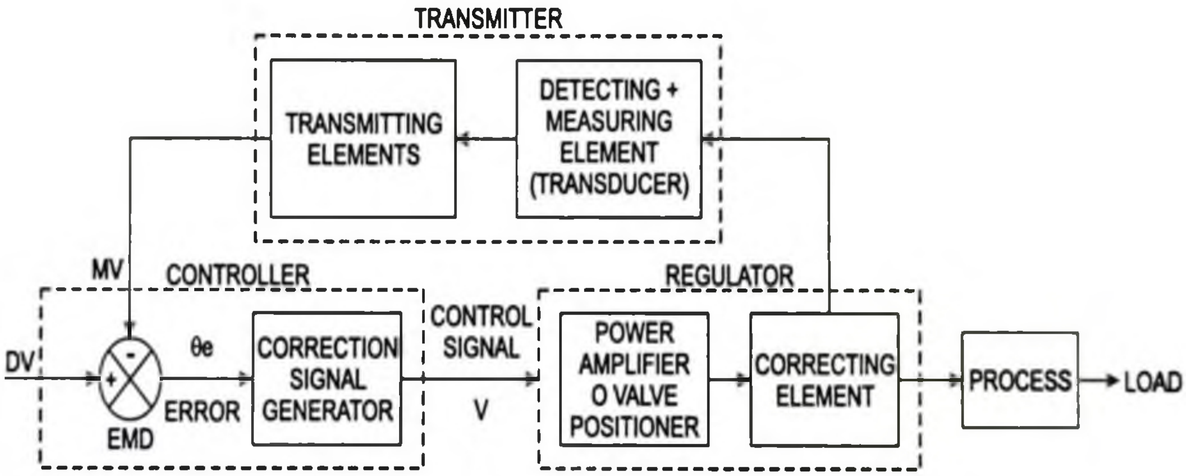

Figure 1 – Enhanced closed loop block diagram

2. The control process

Assuming the load to be steady, that the controller is temporarily out of action and the correcting unit is in a fixed position, it is clear that the measure variable (MV) will reach an equilibrium position for this position of the correcting unit. This attainment of an equilibrium value depends upon the process having "Inherent Regulation" which is the property by which, in the absence of control, equilibrium is reached after a disturbance. This can be shown by a tank of water, which has inflow and outflow. For a given inflow the level will rise to hi such that the outflow q_1 (proportional to $\sqrt{h1}$ is equal to the inflow.

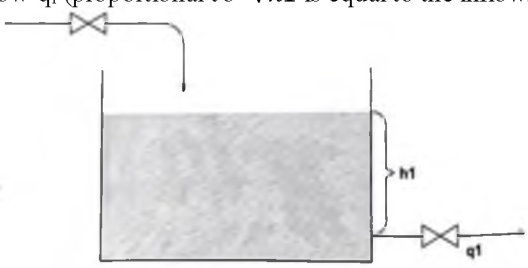

Figure 2 - The process example

3. System order

Consider that in figure 3 the valve offers resistance to the input flow and the tank offers capacitance. The 2 combined form an RC combination. An RC combination can be found in many systems, example: boiler feed control valve (resistance), boiler drum (capacitance). In electronic circuits, there are many resistance/capacitance combinations. One thing common to all resistance/capacitance combinations if the time constant, defined as the time taken for the output to reach 63% of its final value when a step input is applied. The number of major RC combinations in a system determines the system order. A system with one major RC is a first order system whilst one with 2 RC combinations is a second order system, etc. System order affects the output response curve shape when a system is subjected to a disturbance. [2]

3.1. On/Off control

This is a simple control action and is a discontinuous control action. As its name implies a control system of this type is either ON or OFF. This type of control action is mainly used for processes with a high demand side capacity and a low supply side, for example a large hot water system and a smaller heater. Central heating control is an example of this. The room thermostat senses room temperature and compares this with a set temperature. Once the measured temperature falls below the present level the contacts make and start the pump and light the boiler.

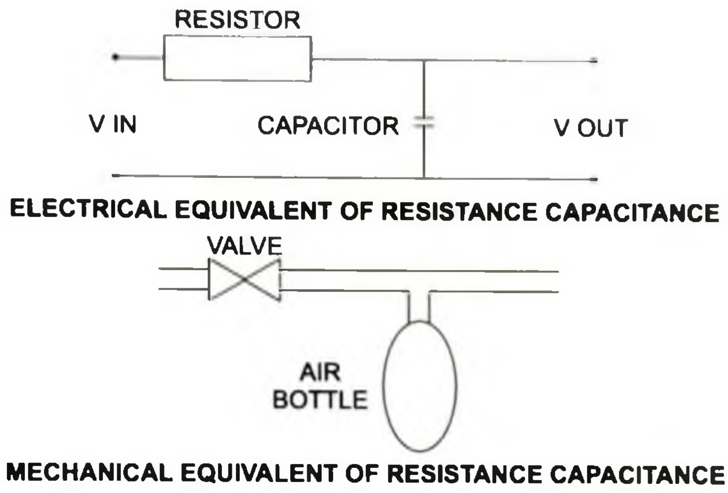

Figure 3 – Mechanical equivalent of resistance capacitance

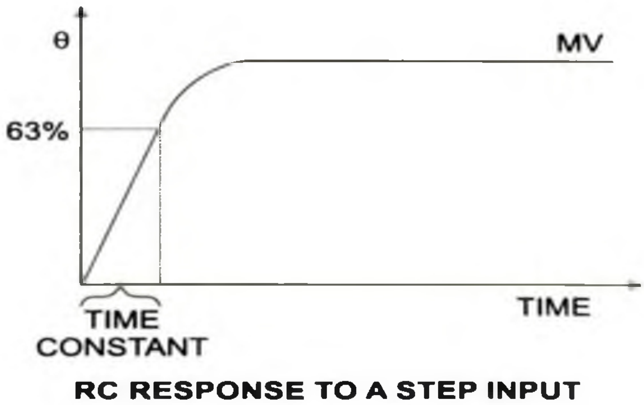

Figure 4 – RC response to a step input

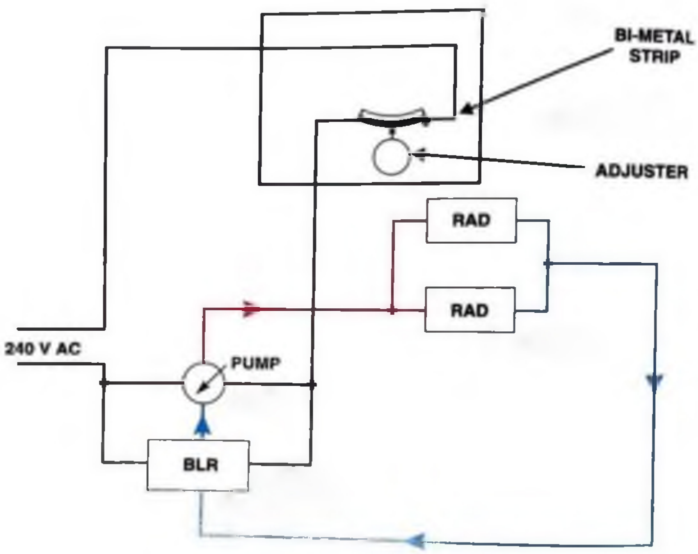

Figure 5 – Basic ON/OFF control system

As room temperature rises above the preset value the contacts open and shut down the system. Room temperature maintained is the average temperature between cut in and cut out values. This results in the graph shown in figure 5. A second example is the control of air reservoir pressure where a spring-loaded switch is caused to operate at a predetermined pressure to either stop the compressor or unload the inlet valves. [3]

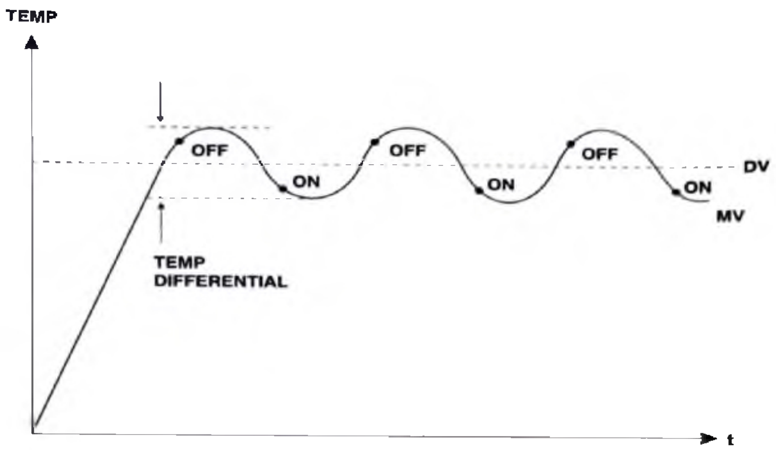

Figure 6 – Heating system temperature graph

ON/OFF control is cheap and simple but has the disadvantage that it can only cater for load changes up to a certain value and so is unsuitable for precision control. Services examples of ON/OFF controls:

- Refrigeration fans.
- Domestic irons temperature controls.
- Hydraulic pumps

3.2. Proportional action

This is the main form of continuous control action but leaves offset or error. In a proportional acting controller, the output signal (V) is proportional (∝) to the error (er) increased or decreased by the controller gain K1.

$$V \propto K1 \cdot er \quad (1)$$

In this form of control, the valve (or device) controlling a process moves by a proportion of its travel when the controlled process moves away from its desired value. Consider a float operated level control system. [4]

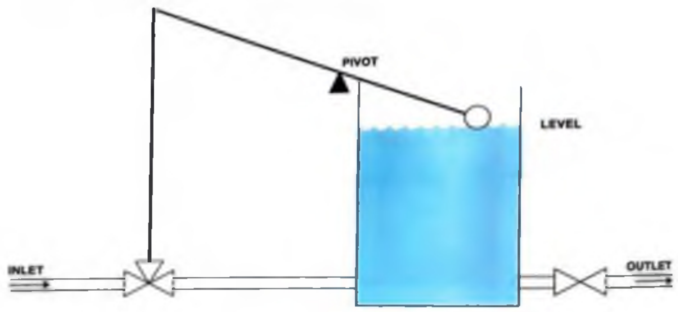

Figure 7 – Simple water level control system

As shown both valves are shut and the level is steady. If the outlet valve is opened halfway water will leave the tank causing the level to fall. The falling level causes the inlet valve to open, which is exactly what is required in order to oppose the falling level. Following the load change, the actual water level is not equal to the desired level. This difference in level is called offset (sometimes error, deviation or droop) and it is an inherent characteristic of proportional control action. Offset had to occur to cause the inlet valve to open. [5]

3.3. Proportional Gain

How much the level had to change is controlled, in this example, by the position of the pivot point. With the pivot close to the ball float, small changes of level cause large valve movement with consequent sensitive corrective action. With the pivot moved away from the float, quite large changes in level will be required to move the inlet valve by a small amount. The system is thus far less sensitive. Is is, in fact, controlling the system gain. Too much gain will make the controlled level unstable. The action is as follows:

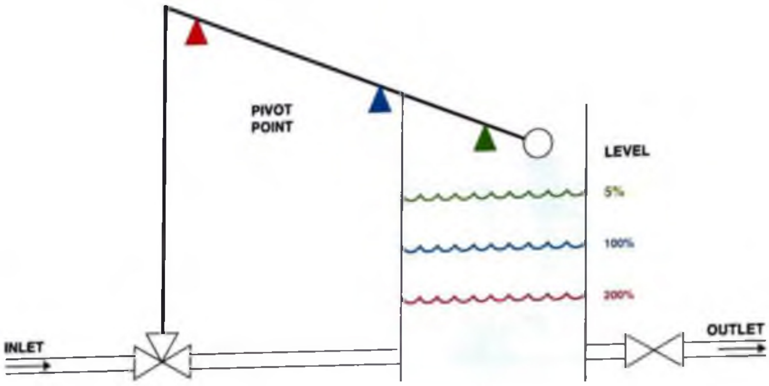

Figure 8 – Water tank with closed loop proportional controller with varying gain

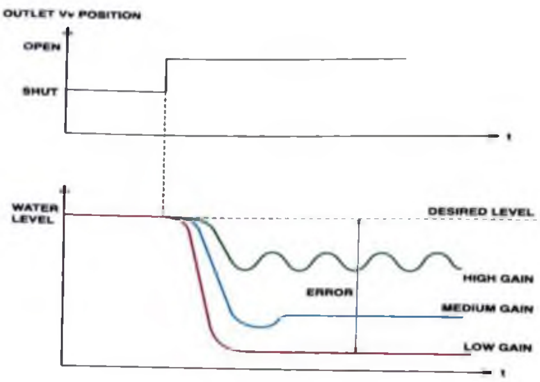

Figure 9 – System response to varying gain

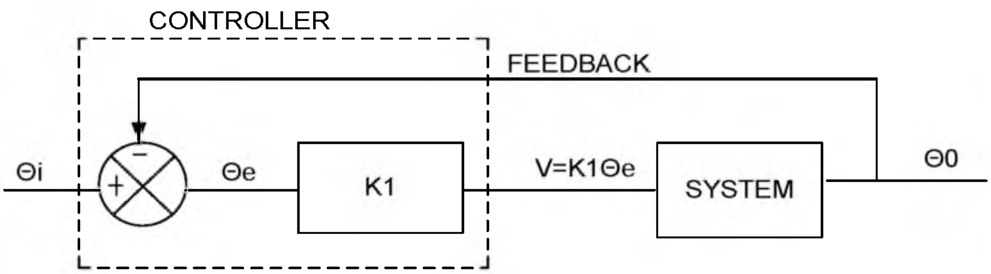

Figure 10 – Closed loop proportional controller block diagram

$$Sistem\ gain = \frac{\theta_0}{\theta_i} = \frac{K_1}{1+K_1} \quad (2)$$

3.6. Proportional band

Controller gain is more usually expressed as percentage proportional band (%PB). Proportional band is the amount the measuring transmitter output (controller input) necessary to produce a full change in controller output expressed as a percentage. It is important to note that the desired value is usually located at the centre of the proportional band. In the above example:[5]

$$\%PB = \frac{\theta_e}{\theta_0} \cdot 100 \quad (3)$$

Or ratio of Input to Output. Gain has already been shown to be the ratio:

$$\frac{Output}{Input} \quad (4)$$

Therefore

$$\%PB = \frac{1}{Gain} \cdot 100 \text{ (Gain = K1)} \quad (5)$$

Therefore

$$Gain = \frac{1}{PB\%} \cdot 100 \quad (6)$$

Exemple

$$Gain = 2$$

$$\frac{1}{2} \cdot 100 = 50\%PB \quad (7)$$

Controllers have %PB ranges usually in the range 2 – 300%. For example, gains of 50 to 0.3. The higher the gain figure, the smaller or narrower the PB. As example, an electrical proportional controller can be considered as an amplifier providing system gain. If, for example, a level controller with a scale ra of 0-5 m has a full output range, i.e., 10 %, for a level difference of plus or minus 0.2 m about a desired value of 1,5 m, then:

Change pf output = 100%

$$PB = \frac{Range\ of\ error}{Range\ of\ control} = \frac{2 \cdot 0.2}{5} \quad (8)$$

$$Therefore\ change\ of\ input = \frac{2 \cdot 0.2 \cdot 100}{5} = 8 = \%Proportional\ Band \quad (9)$$

$$And\ Gain = \frac{1}{\%PB} \cdot 100 = \frac{100}{8} = 12.5 \quad (10)$$

Proportional action is a stable control action that moves the control valve in the correct direction to oppose the change that is happening to the process under control. It puts the control valve in the correct position for the new loading, but leaves offset or error after a load change has taken place. The size of the offset can be controlled using the Proportional Gain control (PB%). Increasing the gain to reduce the offset causes system instability because the higher the gain setting the more sensitive the system becomes. Reducing the gain has the opposite effect. If we can use the offset to produce a further movement to the valve, it should be possible to reduce it further.

4. Conclusions

ON/OFF control is mainly used for processes with a high demand side capacity and a low supply side. ON/OFF control is cheap and simple but has the disadvantage that it can only cater for load changes up to a certain value and so is unsuitable for precision control.

In order to provide engineers with a starting point when set to work on control systems, various empirical formulae must be derived to calculate initial settings for controllers.

The experiments examine the response of various parts of the control system to a step change of voltages in the desired value.

The aim of controls theory is to combine proportional, integral and derivative action in the controller in order to achieve optimum closed loop system response.

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СМЕСИТЕЛЬ ДЛЯ ПРОИЗВОДСТВА БИОТОПЛИВА, ПРИМЕНЯЕМОГО В СУДОВЫХ ДИЗЕЛЯХ

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В статье рассмотрены вопросы приготовления смеси МЭРМ и дизельного топлива. Приведены достоинства и недостатки различных видов смесителей для получения смесевого топлива. Обоснованаконструктивная схема гидродинамического смесителя.Рассмотрен принцип работыгидродинамического смесителя.Сделаны выводы об эффективности применения гидродинамического смесителя в качестве устройства для приготовлениясмеси МЭРМ и дизельного топлива.
Ключевые слова: Судовой двигатель, биотопливо, метиловый эфир, гидродинамический смеситель

MIXER FOR THE PRODUCTION OF BIOFUELS USED IN MARINE DIESEL ENGINES

A.V. Gromakov, A.V. Fil

The article deals with the preparation of a mixture of MERM and diesel fuel. The advantages and disadvantages of various types of mixers for producing mixed fuel are given. Substantiation of the design diagram of the hydrodynamic mixer. The principle of operation of a hydrodynamic mixer is considered. Conclusions are drawn about the efficiency of using a hydrodynamic mixer as a device for preparing a mixture of MERM and diesel fuel.
Keywords: Marine engine, biofuel, methyl ether, hydrodynamic mixer