INSTALLATION OF SAFETY DEVICES ON HYDRAULIC SYSTEM OF EARTHMOVING MACHINERYS

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ABSTRACT

The project is about hydraulic temperature sensor & display unit in earthmoving machine. In this type of live project we have installed a safety system regarding hydraulic temperature on the excavator.

Basically, our project had been done on excavator TATA-HITACHI 450 Z-AXIS. As we had find out the problem in excavator that when the operator is using the machine the working parameters related to temperature render to be blind for the operator which has caused fatal accidents or failure of hose pipes and various other components.

So, to troubleshoot this problem we have installed a temperature sensor on the reservoir so as to maintain the temperature of the hydraulic fluid. An excavator is a type of earth moving machine which works only on the hydraulic pressure energy developed by the pumps on the oil. So oil being the most important component of an excavator we have tried to benefit the user with ensuring safe working conditions.

Hence, the hydraulic oil which keeps building up the pressure inside the mechanism can be kept under controlled temperature and it can help the maintenance of the excavator which used to be blind about the temperature and also reduce the probable chances of breakdowns in the machine.


1. INTRODUCTION

Excavators are heavy construction equipment consisting of a boom, dipper (or stick), bucket and cab on a rotating platform known as the “house”. The house sits atop an undercarriage with tracks or wheels. They are a natural progression from the steam shovels and often mistakenly called power shovels. All movement and functions of a hydraulic excavator are
accomplished through the use of hydraulic fluid, with hydraulic cylinders and hydraulic motors. Due to the linear actuation of hydraulic cylinders, their mode of operation is fundamentally different from cable-operated excavators which use winches and steel ropes to accomplish the movements.

Excavators are also called diggers, JCBs (a proprietary name, in an example of a generic trademark), mechanical shovels, or 360-degree excavators (sometimes abbreviated simply to 360). Tracked excavators are sometimes called "track hoes" by analogy to the backhoe. In the UK, wheeled excavators are sometimes known as "rubber ducks."

2. APPLICATION

- Dashboard and controls of a 3.8 tons excavator
- Excavators are used in many ways:
  - Digging of trenches, holes, foundations
  - Material handling
  - Brush cutting with hydraulic attachments
  - Forestry work
  - Forestry mulching
  - Demolition
  - General grading/landscaping
  - Mining, especially, but not only open-pit mining
  - River dredging
  - Driving piles, in conjunction with a pile driver
  - Drilling shafts for footings and rock blasting, by use of an auger or hydraulic drill attachment
  - Snow removal with snowplow and snow blower attachments

3. CONFIGURATION

Modern, hydraulic excavators come in a wide variety of sizes. The smaller ones are called mini or compact excavators. For example, Caterpillar's smallest mini-excavator weighs 2,060 pounds (930 kg) and has 13 hp; their largest model is the largest excavator available (a record previously held by the Orenstein & Koppel RH400) the CAT 6090, it weighs in excess of 2,160,510 pounds (979,990 kg), has 4500 hp and has a bucket size of around 52.0 m³ depending on bucket fitted.

Engines in hydraulic excavators usually just drive hydraulic pumps; there are usually 3 pumps: the two main pumps are for supplying oil at high pressure (up to 5000 psi) for the arms, swing motor, track motors, and accessories, and the third is a lower pressure (~700 psi) pump for Pilot Control, this circuit used for the control of the spool valves, this allows for a reduced effort required when operating the controls. Generally, the 3 pumps used in excavators consist of 2 Variable displacement piston pumps and a Gear pump. The alignment of the pumps in the excavator unit changes with different manufacturers using different formats.

The two main sections of an excavator are the undercarriage and the house. The undercarriage includes the blade (if fitted), tracks, track frame, and final drives, which have a hydraulic motor and gearing providing the drive to the individual tracks, and the house includes the operator cab, counterweight, engine, fuel and hydraulic oil tanks. The house attaches to the undercarriage by way of a center pin. High pressure oil is supplied to the
tracks' hydraulic motors through a hydraulic swivel at the axis of the pin, allowing the machine to slew 360° unhindered.

The main boom attaches to the house, and can be one of several different configurations: Most are mono booms: these have no movement apart from straight up and down. Some others have a knuckle boom which can also move left and right in line with the machine. Another option is a hinge at the base of the boom allowing it to hydraulically pivot up to 180° independent to the house; however, this is generally available only to compact excavators. There are also triple-articulated booms (TAB). Attached to the end of the boom is the stick (or dipper arm). The stick provides the digging force needed to pull the bucket through the ground. The stick length is optional depending whether reach (longer stick) or break-out power (shorter stick) is required.

On the end of the stick is usually a bucket. A wide, large capacity (mud) bucket with a straight cutting edge is used for cleanup and leveling or where the material to be dug is soft, and teeth are not required. A general purpose (GP) bucket is generally smaller, stronger, and has hardened side cutters and teeth used to break through hard ground and rocks. Buckets have numerous shapes and sizes for various applications. There are also many other attachments which are available to be attached to the excavator for boring, ripping, crushing, cutting, lifting, etc. Before the 1990s, all excavators had a long or conventional counterweight that hung off the rear of the machine to provide more digging force and lifting capacity. This became a nuisance when working in confined areas. In 1993 Yanmar launched the world's first Zero Tail Swing excavator,[8] which allows the counterweight to stay inside the width of the tracks as it slew, thus being safer and more user friendly when used in a confined space. This type of machine is now widely used throughout the world.

There are two main types of "Control" configuration generally use in excavators to control the boom and bucket, both of which spread the four main digging controls between two x-y joysticks. This allows a skilled operator to control all four functions simultaneously. The most popular configuration in the US is the SAE controls configuration while in other parts of the world; the ISO control configuration is more common. Some manufacturers such as Takeuchi have switches that allow the operator to select which control configuration to use.

3.1. Excavator attachments
Hydraulic excavator capabilities have expanded far beyond excavation tasks with buckets. With the advent of hydraulic-powered attachments such as a breaker, a grapple or an auger, the excavator is frequently used in many applications other than excavation. Many excavators feature a quick coupler for simplified attachment mounting, increasing the machine's utilization on the jobsite. Excavators are usually employed together with loaders and bulldozers. Most wheeled, compact and some medium-sized (11 to 18-tonne) excavators have a backfill (or dozer) blade. This is a horizontal bulldozer-like blade attached to the undercarriage and is used for leveling and pushing removed material back into a hole.

3.2. Noble manufacturers
- Bobcat Company
- Bucyrus International
- Case CE
- Caterpillar Inc.
- CNH Global
- Doosan Infracore (formerly Daewoo Heavy Industries & Machinery) - including Solar brand
- ENMTP

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- Hitachi Construction Machinery
- Hydrema
- Hyundai Heavy Industries
- John Deere
- J. C. Bamford (JCB)
- Kanga Loaders
- Komatsu Limited
- LBX (Link-Belt) Excavators
- ThyssenKrupp
- Kobelco
- Kubota
- Liebherr
- LiuGong
- L&T
- Mitsubishi Heavy Industries
- New Holland
- Orenstein & Koppel (O&K)
- Poclain
- Samsung Group

4. CIRCUIT DIAGRAM

![Circuit Diagram of Safety System](image)

**Figure 1** Circuit Diagram of Safety System
Carried out wiring connection as per above circuit.

1. Temperature sensor three wires (Red, White and White) are connected to terminal-6, terminal-7 and terminal-8 of temperature controller respectively.

2. Buzzer positive terminals connected to terminal-4 (NO) of temperature controller. Buzzer negative terminals connected to machine ground.

3. Temperature controller terminal -1 (Positive /Power) and Terminal-5 are connected to key switch M point.

4. Temperature controller terminal-2 is connected to machine ground.

![Figure 2](https://www.selec.com)

**Figure 2** printed circuits on controller

When key switch is turned to “ON” position, our temperature controller will get started as the supply voltage flows from key switch terminal-M to controller terminal-1 and controller will start monitoring hydraulic oil temperature. At the same time temperature reading will be displayed in the display unit of controller.

When actual hydraulic oil temperature rises above the set temperature of controller Terminal-5(COM) will be connected to terminal-4 of temperature controller due to controller internal relay gets energized /activated.

As a result supply voltage which was available at terminal-5 will flows to positive terminal of buzzer via. Terminal-4 and buzzer will siren.

As per machine manufacturer hydraulic oil temperature should be within atmosperic temperature plus 40°C …… i.e if atmospheric temerature is 30°C then machine operating hydraulic oil temperature should not cross 70°C. Below is a hydraulic oil temerature graph downloaded from machine data file.It indicates that max hydraulic oil temeprature of machine in the month of Feb-2017 and Mar-2017 was 70°C to 80°C.
We have analyzed last year summer hydraulic oil temperature reading. Please refer below downloaded graph. It indicates hydraulic oil temperature gone in red zone i.e. over 110°C in some days of April-2017 and May-2017. But still machine operator has runned the machine as he was not aware of the hydraulic oil temperature due to lack of temperature monitoring system for hydraulic oil. We have enquired from site maintenance team.

We have installed monitoring system for hydraulic oil temperature in the machine which enable operator to view or monitor the temperature of hydraulic oil. Also buzzer siren will give signal to machine operator that there is some abnormality in hydraulic system.
This system will reduce the repair cost of machine as some preventive maintenance can be carried after buzzer warring and also improve machine reliability. We have successfully tested our project and set the temperature of controller at 90°C as summer season started and atmospheric temperature may go to about 50°C. We can easily vary set temperature of controller as per our requirement and for warning purpose.

5. COMPONENTS

Figure 5 Hydraulic Oil temperature graph

Figure 6 Terminals

Figure 7 Temperature Sensor

Figure 8 Buzzer

Figure 9 Modification done in Key switch connector
6. INSTALLATION OF CONTROLLER AND BUZZER IN CABIN

**Figure 10** Assembled view of Temperature controller

**Figure 11** Cabin view and controllers
7. CONCLUSION

Installation of this pressure indication device can insure safe working condition. The maintenance cost of excavator regarding engine get low down. Observations and maintenance of the oil would be easy. The hose pipes are under continuous pressure and undergo forces, their discharge rate can be kept under control. The most helpful function of this system is that it doesn't need any skilled labour to understand the function and operate this device. There is a great scope of this project as it is not so costly and the materials required for the project are available in the market. The prototype system is only a single module for testing and analysis of project. If the project shows positive response then it can be converted into a large system and we can implement in all excavators and various applications. As by implementing this fabulous sensor unit in all vehicles and bigger machineries where hydraulic oil takes place we can ensure there low maintenance cost & also ensure safe working conditions.

REFERENCES