

# 1 Problem Statement

## SIH PS No - AK210

### Design of Energy Efficient Regenerative Hydraulic System for 100 Ton Excavator

#### Description of the problem

An excavator is a construction vehicle used to excavate or move large objects. The excavator uses a Hydraulic system to generate a Hydraulic force to control the mechanical arm of the machine. It also uses a crawler system for its movement.

The main sections of an excavator are the undercarriage assembly, revolving frame assy. The undercarriage assembly includes tracks, track frame, and final drives, which have a hydraulic motor and gearing providing the drive to the individual tracks. The revolving frame assembly includes the operator cab, counterweight, engine, fuel and hydraulic oil tanks and work attachment of boom, arm & bucket its actuating cylinders, the swing system has swing machinery of gearbox and driving swing motors with hydrostatic primary brake and parking brake as secondary for safe operation of excavator. The hydraulic control system is actuated by operator sitting in operator cabin seat with Hydraulic joystick. The revolving structure attaches to the undercarriage by way of slewing bearing system. High pressure oil is supplied to the tracks of hydraulic motors through a hydraulic swivel joint at the axis of the swing centre, allowing the machine to slew 360° unhindered and thus provides the left-and-right movement.

Saving energy of construction machinery, especially the hydraulic excavator is very essential. The development of new energy saving solutions and efficient hydraulic system have become a priority for equipment manufacturers.

The excavator swing system has high inertia energy and swing system used nearly 20~30% of load cycle for general applications. The brake of swing system inertia energy can be stored and used for other applications. The concepts of energy storing has a challenge and need to identify best solution.

The hydraulic excavator functional video is attached for easy understanding of

functionality in MP4 format. (BE1000hyd.mp4)



BE1000Hyd.mp4

### Outcome expected:

1. Propose **Swing brake energy** regeneration Hydraulic system for 100 ton Excavator.
2. Concept needs to be described with block diagram and working principle indicating regeneration of hydraulic energy storage to be described in hydraulic system line diagram.
3. The proposed energy regeneration system to be verified through software simulation.
4. Need to explain the functional block model, methodology, Algorithm and flow chart used.

### BE1000 Excavator Product Specification:

Flywheel Horse Power (FHP)	: 542 hp @1700 Rated RPM
Operating mass	: 98000 kg
Bucket capacity	: 4.5 m <sup>3</sup> -7.0 m <sup>3</sup>

#### Hydraulic pumps

1. Two variable capacity tandem pumps power the boom, arm, bucket and travel circuits.  
Capacity (discharge flow) at rated rpm : 2x628 lpm
2. One variable capacity piston pump powers the swing closed loop circuit.  
Capacity (discharge flow) at rated rpm : 1x405 lpm
3. Tandem gear pump powers the Pilot + PTO lubrication circuit.  
Capacity (discharge flow) at rated rpm : 1x (49+24.5) lpm

Hydraulic Motors : 4-variable displacement axial piston motors

#### Operating Pressures

Implement circuits	: 320 bar (kg/cm <sup>2</sup> )
Travel circuit	: 320 bar (kg/cm <sup>2</sup> )
Swing circuit	: 300 bar (kg/cm <sup>2</sup> )
Pilot circuits	: 35 bar (kg/cm <sup>2</sup> )

#### Hydraulic cylinders: (Backhoe)

Cylinder	Qty (numbers)	Bore x stroke (in mm)
Boom	2	225 x 2200
Arm	1	250 x 2015
Bucket	1	225 x 1630

#### Hydraulic cylinders: (Loading shovel)

Cylinder	Qty (numbers)	Bore x stroke (in mm)
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Boom	2	225 x 1850
Arm	2	180 x 1765
Bucket	2	200 x 1530
Bottom dump	2	140 x 435

Swing System

Swing Speed	: 4.5 r/min
Maximum Grade ability	: 30 <sup>0</sup>

**Existing Hydraulic system arrangement : BE1000 Excavator Loading Shovel**



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