

Closed vs. Open Loop Configurations for Hoisting Applications

General Background:

Seatrax uses an **open loop configuration** for all of its **variable displacement hydraulic systems**, which are used for **hoisting applications**. These systems utilize the same type of **variable displacement, high pressure, piston pumps** that are used on the more familiar **European closed loop systems**. Seatrax's **open loop configuration** for this same type of equipment provides equal or better **infinitely variable speed control** in both directions of movement and addresses well-known safety and maintenance concerns that continue to be a problem with the **closed loop system configuration**.

Problems with Closed Loop Systems:

The **pump** on a **closed loop circuit** discharges directly to the **hydraulic motor**. Flow from the **motor** is directed directly back to the **pump**. The fluid moves in a loop from which it does not escape. Directional control is accomplished by rotation of the **pump swashplate**. The position of this **swashplate** selects the direction of **pump** flow (**up** or **down**) or, if the **swashplate** is vertical, no flow occurs (**neutral**). The nature of this system creates certain problems in crane applications, which are described below:

Dynamic braking is accomplished by attempting to **back drive** the **pump**. The **pumps** and **prime mover** constitute the **dynamic brakes**. This has several disadvantages:

- In the event that the **prime mover** is a **diesel engine**, this **engine** must be develop sufficient power to drive all three primary crane motions at full load and full speed at the same time. Otherwise loss of **dynamic braking** capability can occur because of **engine** overload while lowering the **boom** and the **hook** simultaneously. For this reason, the **engine** must run at high speed when the crane handles any substantial load. Otherwise, the load may **overrun** and kill the **engine**. **Prime mover** failure can result in loss of control of the load.
- A hydraulic line rupture between the **pump** and **motor** will drop the load. This means that the **hydraulic fluid conductors** must be classified and treated as **critical components**.
- The **servo** controls that operate the **pump swashplate** all seem to have trouble holding an exact **neutral** position from time to time. This **neutral shift** permits the crane to move about unintentionally without input from the crane operator. Many accidents have resulted from this cause. Most crane specifications require one or more **panic buttons** or **emergency stops** to deal with this situation. Also, the controls on a crane with this type of system should never be left unattended with the **prime mover** running.

The fact that the flow of hydraulic fluid is primarily in a **closed loop** causes certain other problems, which include:

- It is very hard to properly filter the **hydraulic fluid** because most of it does not escape from the **closed loop**. This means that contaminants are constantly circulated from the **pump** to the **motor** and back again. In many systems, **high-pressure filters** are placed in the loop to attempt to deal with this problem, but they can only operate in one direction and are prone to leakage. Also, they are easy to plug up.
- It is very difficult to properly cool the **hydraulic fluid** in a **closed loop** system. These systems are efficient but generate a lot of heat. This heat can only be dissipated by cooling the flow from the **charge pump circuit**. This flow is a small percentage of the total flow through the loop, so this process is not effective. For this reason, cranes with **closed loop systems** have historically had overheating problems when used in tropical or semi-tropical applications.

Advantages of Open Loop Systems:

The **pump** on an **open loop** system draws fluid from a **storage tank** or **reservoir** and then discharges it to a **directional control valve**, which is used to select **up**, **down** or **neutral**. Flow from this **valve** goes to the **motor** and back to **tank (up or down)** or goes directly back to the **tank** when in **neutral**.

This configuration overcomes the problems associated with **closed loop systems** as described below:

Dynamic braking is accomplished by means of a **motor control** or **counterbalance valve**, which is normally fitted directly to the **hydraulic motor**. The energy of lowering the load at a controlled speed is converted into heat in the **hydraulic fluid** by forcing it to flow through a small orifice at high pressure, so the **prime mover** plays no role in **dynamic braking**. This means the **prime mover** need not be sized based on the potential full power requirements of the three primary crane motions. For this reason, a failure of the **prime mover** cannot and will not result in loss of control of the load.

If the **prime mover** is a **diesel engine**, it is not necessary to run it at high speed. Full-rated loads, on both the **boom** and the **hook**, can be lowered under full control with the **engine** operating at idle speed.

- A **hydraulic line** rupture cannot cause the load to drop because load holding is performed between the **hydraulic motor pistons** and the **spool** in the **counterbalance valve**. This means that the **fluid conductors** are not critical components in this type of system.
- **Neutral creep** in the **pump swashplate servo** cannot cause the crane to move unintentionally because the **directional control valve** will divert any unexpected flow directly to **tank** as long as the control handles are centered.
- It is very easy to filter the **hydraulic fluid** because the fluid passes through the **tank** whenever a **hoist** is in operation. This makes it practical to filter the oil on a continuous basis by means of a separate **fluid conditioning circuit**.
- It is also very easy to cool the **hydraulic fluid** by means of a **large oil cooler** fitted in the **fluid conditioning circuit**. This overcomes the overheating problem common with **closed loop systems**.