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Innovative Hydraulic Systems For Harbour And Container Cranes

Crane hydraulics in ports and dockyards

The demanding operating conditions, large loads and 24 hour working associated with portside container cranes means high-performance hydraulic systems are required. Ruppel Hydraulik has developed and produced a wide range of system solutions for harbour cranes, including compact hydraulic units for sway control, as well as complete hydraulic units for heavy-lift harbour cranes and automated cranes.

Because they operate under harsh environmental conditions, moving large loads or load configurations, harbour cranes are a challenging field of application for hydraulics. Ruppel Hydraulik is able to benefit from considerable experience in this particular field. The company has developed a hydraulic sway control system which has been retrofitted to many harbour container cranes across the world. The system is as simple as it is effective, significantly increasing the cargo handling capacity of a crane (see infobox).

Hydraulic system for 150-tonne harbour crane

However, Ruppel Hydraulik can also call on extensive expertise in the planning and design of complete hydraulic systems, e.g. for ship hydraulics, as well as for complex systems used in marine engineering.

Taken together, this expertise is an excellent basis for the development and supply of complete hydraulic systems for harbour cranes. Recently, for instance, the company designed the full hydraulic system for the work duties of a mobile har-bour crane with 150-tonne lifting capacity.

Cranes of this kind run freely across the port or dockyard area on a multi-axle chassis. A lattice-type derricking boom is located more or less in the centre of a short vertical mast. The guying is attached to the top end of the mast, and, unlike the usual types of mobile crane, the derricking cylinders are above the boom. Hefty brace supports ensure crane stability when handling heavy loads.

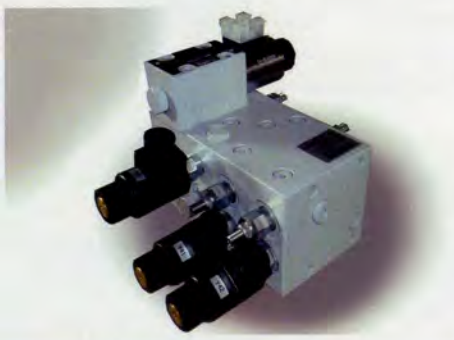

Figure 1: Ruppel Hydraulik developed a complete hydraulic unit to take care of the work duties of a 150-tonne mobile harbour crane. The illustration shows one of the hy-draulic blocks.

Control circuits for derricking and brace supports

The power output of the hydraulic unit for this crane is provided by two 160 kW axial piston pumps with a maximum volume flow of 270 l/min, load-sensing con-trol and pressure cut-off (Figure 1). One of the items to which they supply hy-draulic power is a proportional directional control valve which regulates the in/out movement of the derricking cylinders. A control circuit composed of pressure regulating valves on the pump control blocks, plus pressure sensors in the cylin-ders, ensures that the pressure in the cylinder chambers always remains the same during their simultaneous operation.

The brace supports are initially swung out to the sides and then extended vertical-ly – always all four of them together. Here too, a control circuit with pressure monitoring ensures the operating sequence is optimised. The support cylinders are extended at reduced pressure until they make contact with the ground, or in more precise terms, until equal pressure is achieved on all four cylinders. It is then up to the crane operator to ensure the crane is levelled off. During this operation too, the pressure in all four cylinders is continually monitored.

The drive system includes a comprehensive array of safety functions, such as brake valve blocks for the derricking cylinders and brace supports, as well as an accumulator and electric brake for the winch. The hydraulic unit has already been installed, and the crane is now working to the full and complete satisfaction of the company which operates it.

Modification of an existing automated crane

As an owner-managed, engineering-driven company, Ruppel is also an important point of contact for crane manufacturers and operators interested in single-batch retrofit projects. We have a recent example of this aspect as well. For ship-to-store handling of bulks such as fertilisers, a port authority had ordered a rail-borne crane capable of performing automatic unloading of ocean-going vessels (Figure 2). The crane was not achieving the agreed performance values, but before it could deal with its shortcomings, the manufacturer went bust.

After an analysis of the crane's current operating condition, experts from Ruppel Hydraulik came to the conclusion that the electro-hydraulic control system of the crane's boom and grab was not

Figure 2: This automated crane used in bulk goods transfer required high levels of positioning accuracy for its derricking boom and grab.

capable of achieving the required accuracy. This was because the actual value for grab position was only detected via rotary encod-ers on the boom and subsequently calculated. Moreover, the hydraulic positioning using solenoid valves was based exclusively on volume flow control of the pumps, which at around 850 l/min is extremely powerful.

Ruppel Hydraulik drew up an alternative proposal, which is currently in the pro-cess of being implemented. Positioning of boom and grab is controlled via pressure regulation in combination with a directional control system on the cylinder. The pump oil flows are controlled directly by a proportional directional control valve fitted to the cylinder. An additional two-way pressure-maintenance valve ensures the hydraulic control is pressure-compensated, allowing it to work largely independently of temperature and load. Based on Ruppel's calculations, this set of measures will result in an improvement in repeat accuracy for grab position from well over +/-10% to under +/-3%. This value is completely adequate for bulk goods transfer operations.

Hydraulic Sway Control System For Container Cranes

Ruppel Hydraulik's global presence in harbour crane technology is not just based on engineering projects – it also has a very specific product of its own. Many port container terminal operators use the hydraulic sway control system developed by Ruppel for container cranes, as they save time and berth dues on every transfer operation (Figure 4).

The principle behind this sway control unit is quite simple. Four lifting cables are guyed diagonally to the direction of sway. A cylinder is used to perform the duties of actuator, and a compact control block acts as the "brain". The cylinder, at 190 cm in length, tensions the anti-sway cables.

The latest generation of this sway control system is fitted with electronic control. This allows more accurate, proportional adjustment and monitoring of the system pressure. The result is that any tendency to sway is prevented even more effectively, and the crane does not just work faster, but also uses less energy. This is because swaying motions inject unwanted kinetic energy into the sub-system of lifting gear, load-carrying unit and load, which the crane then eliminates by applying its brakes.

Figure 4: The sway control unit developed by Ruppel allows container cranes to work faster, so that the unit very soon pays for itself.

Figure 3: Valve blocks for the automated crane. Where necessary, the valves used by Ruppel Hydraulik were tailored to requirements, e.g. by using fully customised pistons.

Customer-specific valves for crane hydraulics

Over the years, Ruppel Hydraulik has also worked on other extensive projects in (harbour) crane engineering. Because these cranes often use powerful hydraulic drives and there is a need for highly sensitive positioning of e.g. the crane boom, pilot-operated proportional valve technology using solenoid valves is often de-ployed in the control blocks. The valves are always bought in (Ruppel is after all not a valve manufacturer), but some are adapted to meet the exact requirements of the relevant task, e.g. by re-equipping them with customised pistons (Figure 3).

The above examples go to show that by using its special know-how, Ruppel Hy-draulik can compete on equal terms with major global players when it comes to designing harbour and other crane types. It can develop solutions which fully ex-ploit all the advantages inherent to hydraulic systems: excellent power density, superb control characteristics, robustness and energy efficiency.

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