Keeping weight in control

The feature highlights technology USPs like 5,000-psi technology provided by Eaton’s Aerospace Group for Airbus’ A380, the world’s largest passenger aircraft. This technology has not only slashed weight but also boosted reliability, fuel efficiency and operating performance.

When Airbus set out to design the world’s largest passenger aircraft, the A380, weight reduction was critical to program goals. In 2001, Airbus awarded the hydraulic system contract to Eaton’s Aerospace Group, a world leader in aircraft hydraulic power generation, fluid conveyance and motion control systems.

In addition to using lightweight, advanced materials in the airplane’s construction, Airbus wanted innovative systems that not only slashed weight but also boosted reliability, fuel efficiency and operating performance. Central to Airbus’ vision was the A380 hydraulic system, which would be required to operate some of the world’s largest flight-control surfaces, landing gear and utility systems. For example, the A380’s tail is as big as the wing of a typical 150-passenger aircraft.

Figuring out how to increase hydraulic system power while reducing aircraft weight called for unique and novel engineering solutions. Applying its vast experience in higher-pressure military aircraft hydraulic systems, Eaton answered the challenge by designing the world’s first higher-pressure 5,000-psi commercial hydraulic power generation system for the A380. The revolutionary new system, unveiled by Eaton, was hailed by Allan McArtor, Chairman, Airbus Americas, Inc., as “a tremendous historical achievement for Airbus, Eaton and the industry.”

“The development of the 5,000-psi (34,475 kPa) power generation system is a great example of Eaton’s continued growth as a solutions provider for the industry, especially with the increased focus on higher fuel efficiency and lower emissions,” said Jay Iyengar, Vice President — Engineering and Technology, Eaton’s Aerospace Group. “Eaton contributed significant original engineered content on the A380 that helped Airbus achieve program goals and paved the way to performance breakthroughs for next-generation aircraft.”

The 5,000-psi system was just the beginning of Eaton innovations on the A380. The company developed a broad array of products and technologies that optimized efficiency, reliability, safety and weight savings. It also worked with engine manufacturers to meet new performance criteria for fuel...
The 5,000-psi technology

Eaton’s leadership and experience in 4,000-psi to 8,000-psi (27,579 kPa – 55,158 kPa) hydraulic fluid power technology spans four decades and has contributed significantly to critical component weight and volume reduction in overall aircraft system design.

Elevating the hydraulic system pressure standard for commercial passenger aircraft from 3,000 psi to 5,000 psi (20,685 kPa – 34,475 kPa) enabled Airbus to achieve significant weight savings by reducing the diameter of hydraulic fluid lines and the size of components that operate the primary flight-control system. Eaton solutions for the A380 eliminated a full metric tonne of additional weight, which made a significant impact on fuel efficiency and emissions reduction.

The A380’s fuel burn is around 13% lower than its closest competitor, and it’s also the first long-haul aircraft to consume less than three litres of fuel per passenger over 100 km (95 miles per imperial gallon) — a fuel economy comparable with small, modern turbo-diesel cars.

The total Eaton system includes eight engine-driven hydraulic pumps per aircraft and four 5,000-psi (34,475 kPa) AC motor pumps with associated electronic controls and protection systems. The hydraulic pumps provide fluid power to the aircraft’s primary flight controls, landing gear, nose wheel steering and other aircraft utility systems.

Each pump is powered by the engine accessory gearbox and delivers a rated flow of 160 l/min (42 gpm) at 3,775 rpm. The pump integrates an 11-piston rotating group coupled with a spherical-type attenuator, boost impeller, electrical depressurisation valve and scaveng pump.

Eaton’s higher-pressure pumps are also the first commercial units designed to incorporate a manual and electrically actuated disengage clutch mechanism. The ability to mechanically disengage from the main engine gearbox prevents fluid contamination from entering the hydraulic system and
significantly improves operational availability to the service airline. The action can be safely accomplished in flight or on the ground.

Hydraulic system reliability

In the unlikely event a pump issue is detected, Eaton's patented clutch allows aircraft service technicians to manually disconnect pumps from the engine transmission. Unlike previous system architectures, this feature helps airlines dispatch aircraft on time, thereby avoiding passenger delays. If a hydraulic pump issue is detected in flight, pilots can electrically disengage an engine's pumps, which can minimise further damage to hardware and avoid potentially costly repairs.

Each of the A380's four engines has two engine-driven pumps, plus four 21.3 kW electric motor pumps that are used primarily during ground servicing and a slat drive system that incorporates a bi-directional variable displacement hydraulic motor — another first for a commercial aircraft.

In addition to supplying higher-pressure pumps, Eaton designed pumps with significantly lower pressure pulsation levels, even lower than seen in traditional 3,000-psi aircraft systems. Eaton lowered pressure pulsation levels by increasing the number of pump pistons, which improved the pumps' ripple performance, and integrating an inline attenuator into the pump design. The attenuator dampens and reduces the pump's outlet pressure pulsations by as much as 98%.

Isolating the aircraft system from pump-generated pressure pulsations lowers wear rates on moving parts of hydraulic system components and reduces strain on hydraulic lines and fittings. The company's pump innovations help operators reduce overall system operating costs by providing improved hydraulic system reliability.

Innovations in A380

Eaton produced a number of product and technology innovations to match new performance requirements for the A380. The company provides the A380's hydraulic fluid distribution technology standard, including the Rynglok™ tube-fitting system and hose products. The Rynglok tube-fitting system was specifically designed for higher-pressure hydraulic power generation systems. The all-metal lightweight titanium alloy construction and "zero-leak" design make it an ideal standard fitting technology for the A380's overall hydraulic fluid conveyance system, which includes primary and secondary flight controls and landing gear.

The company also developed new wing-transfer fuel-pump technology for the A380. It supplies a total of 21 electrically driven fuel pumps and associated canisters for each aircraft that transfer fuel from various tanks to the aircraft's engines and also between tanks during flight. The transfer system consists of three different pump types (transfer, engine feed and trim) that operate from a variable frequency power supply—an innovation in fuel-pump system design.

The fuel pumps use brushless DC motors, with power conditioning and control electronics incorporated into the pump design. The fuel itself serves as the cooling medium. Pumps are fitted in tank-mounted canisters that enable them to be removed without having to drain the fuel tank.

The company contributes technologies that improve the A380's safety, such as fuel and inerting systems and fire shut-off valves. Inerting systems enhance aircraft safety by injecting inert gas into fuel tanks to significantly reduce the potential for ignition sources, while fire shut-off valves are used to shutoff the hydraulic line at the pump inlet in the event of major system or engine failure.

The A380 is equipped with four fire shut-off valves fitted with size 32 hydraulic ports that are designed for nominal flow of 350 l/min under a pressure of 220 psi (1,516.9 kPa).

Powering & protecting A380 engines

Eaton is a key program supplier not only for Airbus but also for both engine models designed to power the A380. One model features an engine build-up system developed by Eaton that comprises nine sub-systems containing more than 85
Eaton-designed components. These engine sub-systems support cabin air, starter air, thermal anti-ice, hydraulics, variable frequency generator cables and cooler pipes, drains and fire extinguishing.

Both engines are equipped with Eaton oil debris-monitoring technologies that detect particles in lubrication systems to determine if critical engine component failures are imminent. These technologies include a chip detector, which uses a magnetic plug to draw ferrous particles from lube oil and an indicator light to signal when chip counts increase; and Eaton’s quantitative debris-monitoring system, which enhances engine health and aircraft safety by capturing, retaining and analysing oil debris particles.

The quantitative debris-monitoring system not only separates particles and air from oil, but also employs a magnetic, inductive particle sensor that analyses the number and size of particles for a more accurate and detailed assessment of engine activity. The sensor sends signals to a conditioner that generates a digital pulse when a particle’s mass exceeds a preset threshold.

In addition to the sensor and signal conditioner, Eaton’s oil debris-monitoring system includes the patented Lubriclone* three-phase vortex debris separator, the industry’s only high-efficiency deaerator fitted with QDM*. Higher efficiency allows the oil reservoir to be smaller, which provides weight savings in addition to earlier, more accurate information about engine conditions. Data is relayed to pilots and maintenance crews so actions can be taken, if necessary, to prevent engine damage and improve flight safety.

"The many solutions developed for the A380 program demonstrate Eaton’s focus on being a lifecycle partner with our customers, which means much more than simply providing them with a product or service," Iyengar said. "We look at the big picture in our development programmes to anticipate and address issues that will help customers improve aircraft performance, increase fuel efficiency and control cost over the long term.”

Courtesy: EATON

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