BUCHER hydraulics

Technical article

AX: Hydraulic Motor 2.0

Hydraulic drives still offer a wealth of potential – they will carry on being indispensable in the future

What is special about a twelve-cylinder motor? Its silky-smooth running. And with that, we have already described one basic principle of the new AX motor. It was developed by Bucher Hydraulics, whose engineers have systematically consolidated the fundamental advantages of the hydraulic motor over electric drives and eliminated its disadvantages.

Off-road vehicles for construction, agriculture, forestry, materials handling and other special purposes are machines where power from a limited installation space is particularly important. Although the move to electrical power is making some progress in this area, it can only replace the limited number of hydraulic drives that do not need to produce the highest forces. These are mainly the auxiliary drives. A purely electrical drive in machines would require a powerful high-voltage technology. For example, voltages of up to 1,000 volts are already being used in the automotive sector. This is the exception for mobile machines, however, especially as there is still no broadly based support infrastructure for such high-voltage technology.

Possible application of an AX motor on a winch.

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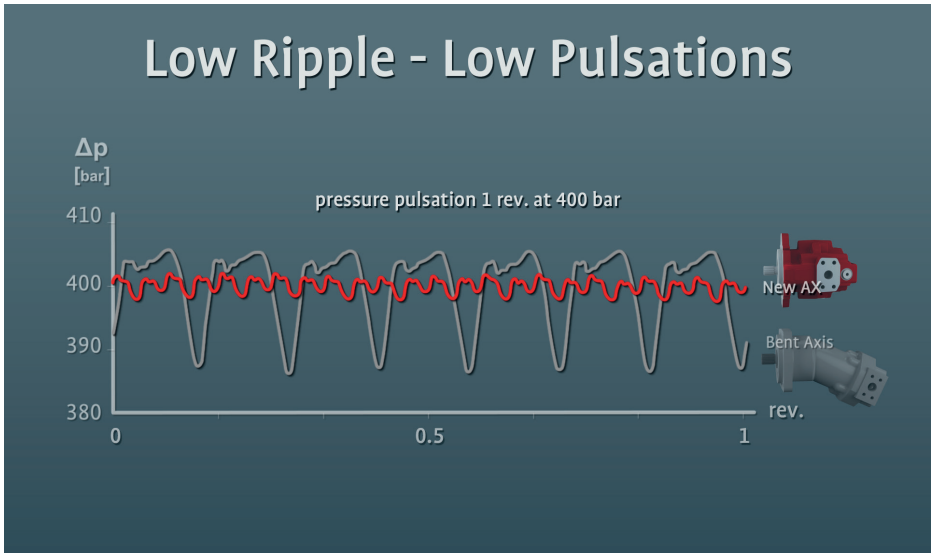
Hydraulics remains indispensable

The high power density of hydraulics (power/kilogram weight) and the very compact dimensions of the hydraulic motor make it indispensable for the real work of mobile machines, and this will continue to be true in the future. Hydraulic motors have some significant advantages over electric drives. Their ability to deliver continuous, high-power operation without the need for an external cooling circuit is reassuring. In spite of the adverse environmental conditions that mobile machines routinely encounter – water, dust, mud and vibrations – hydraulic motors are extremely reliable, thus ensuring a high level of 'up time'. And they conserve resources, because they do not require expensive materials such as copper or rare earths. This also makes them very competitive in terms of price, particularly because hydraulic energy is not an optional extra – it has to be provided on most mobile machines in any case.

That's one side of the argument. On the other side, electric drives score with excellent controllability and high efficiency. They are quiet and have low torque pulsations. This means that the developers of the hydraulic motors have to "do their homework" in order to remain competitive. Hydrostatic travel drives on construction sites attract immediate attention because of their unpleasant noise level, and all the more so as the power units of other mobile machines become ever quieter. The efficiency also needs to be improved, as electric motors score highly here as well. What makes matters worse is that hydraulic drives only achieve their best performance in a relatively narrow operating field. Particularly at high power levels, the natural domain of hydraulics, the efficiency usually drops off and the highest power losses occurs.

Problems also arise with drives that have to start under high torque: in winches, or vehicles for steep inclines, for example. Breakaway effects lead to a lower start-up efficiency. Applications that demand very slow and uniform working movements need larger motors than are actually necessary. Various additional measures can reduce the symptoms of breakaway effects, but of course result in extra work and thus in higher costs.



The pressure pulsation from AX motors is of the same order as that of electric motors.

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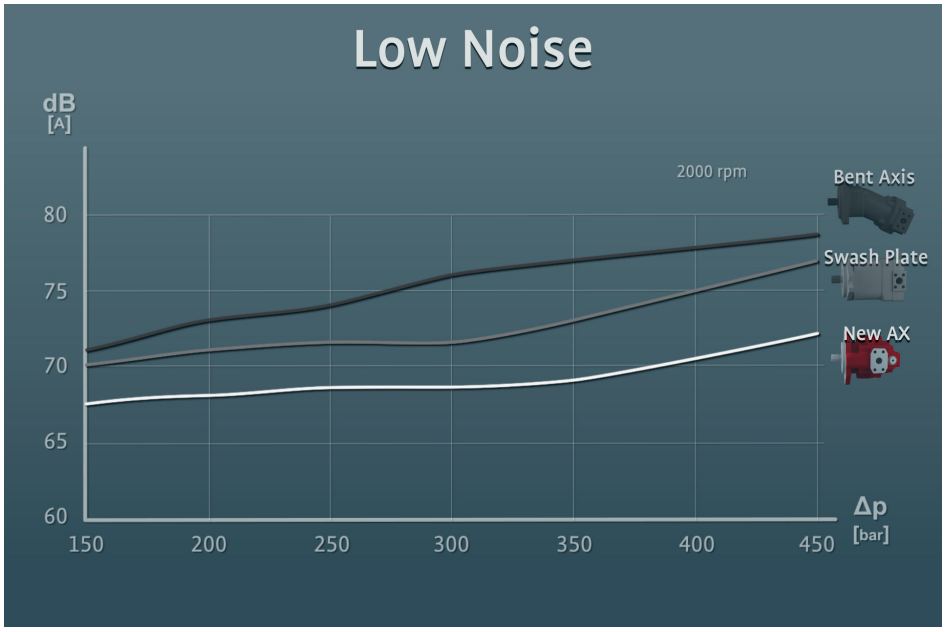
24 pistons instead of 7

Today's common hydraulic motors are usually designed with seven or nine pistons, but at low speed and high torque this results in the dreaded torque pulsations and uneven working movements. Crane jibs and other parts can quickly start to oscillate. The non-compensated forces typical of bent-axis motors must be absorbed by a large ball- or roller-bearing. Despite decades of development and a high degree of product maturity, these disadvantages still cannot be solved satisfactorily with today's technology.

In developing the AX motors, Bucher Hydraulics therefore took a completely new approach in order to eliminate the disadvantages of today's hydraulic motors. The result is truly revolutionary. The AX hydraulic motors have characteristics that would otherwise only be possible with electric drives. The new principle: the internal forces in the AX motors cancel each other out thanks to the use of two opposing rotating piston units, each equipped with twelve pistons. Not only does this increase the power density substantially, it also limits the axial forces, and a light-duty bearing is sufficient to absorb them.

This internal force-balancing also results in a lower noise level than has ever been achieved to date. At 350 bar [5,000 psi] working pressure (maximum possible continuous pressure 450 bar [6,500 psi], peak pressure 500 bar [7,250 psi]) and 1,500 rpm, it is an acoustically comfortable 64 dB(A). For comparison: this roughly corresponds to the volume of a normal conversation at a distance of one meter and does not pose any problems under the rules of occupational health and safety. This eliminates an unpleasant source of noise in the working environment of mobile machines. The low noise level also saves on costly sound-insulation measures.



AX motors are very quiet. They are perceived as half as loud compared to existing axial piston motors.

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Power loss is halved

In principle, the inline design of the AX motors makes them similar to electric motors, as the usual, often troublesome, bent-axis construction is avoided. The total of 24 pistons in the AX motor virtually eliminates pulsations, even at the lowest speeds. The large uncompensated forces that exist in conventional axial-piston motors not only require large bearings or long pistons, they are also associated with a relatively high power loss. The AX design principle eliminates the causes of friction and wear, resulting in a very high mechanical efficiency. The low friction roughly halves the power loss and thus also the heat input into the oil circuit as well as the amount of flushing needed for cooling.

The overall efficiency of the AX motors is between 92 and 94 percent – and this is over a wide operating range. The starting efficiency is 99 percent. Even under maximum load there is therefore no breakaway effect. This is in marked contrast to conventional axial-piston motors, which have a starting efficiency of only 60 to 65 percent – with the resulting stick-slip effects mentioned above. Since the hydraulic motors no longer have to be designed for a poor starting efficiency, their displacement can also be correspondingly reduced.

What does this mean in practice? AX motors reach their operating speed at a lower flow rate. Depending on the requirements, they can be operated with a higher or lower drive power.

High starting efficiency without any stick-slip effect: This makes smooth starts possible without any additional measures.

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Conclusion: AX motor – the profit maker

With the new AX motors, the outcome of several years of research and development work, Bucher Hydraulics eliminates the previous disadvantages of hydraulic drives when compared with electric motors. At the same time, the advantages of hydraulics are fully retained. Manufacturers of high-performance mobile machines are finding completely new ways of offering their customers drives with unique advantages that could otherwise only be achieved by using electric motors.

High power density, high working pressure and a minimum permissible speed that is exceptionally low make AX motors the obvious choice for transmission motors. They ensure the most precise working motions and thus simplify and speed up the assembly of heavy components when using the hoist winch and slewing gear in crane applications, for example. Thanks to the elimination of the breakaway effect, costly additional measures are no longer necessary. The jerk-free and smooth rotations at low speed lead to better results. Reduced noise emissions also make it simpler to use the motors in cities, and they meet the increasingly stringent restrictions on construction work in existing buildings. The flushing circuit and the cooling system can be made smaller. That reduces the installation space required and lowers costs. The significantly higher efficiency saves fuel and thus reduces CO2 emissions.

Maintaining good lubrication does not require a minimum speed to be specified. Under these operating conditions there is virtually no wear and tear, so the reliability is very high. The motors are currently available with displacements from 18 to 76 cubic centimeters per revolution [1.1 to 4.6 cu. in./rev] Units of up to 115 cubic centimeters per revolution [7.0 cu. in./rev] have already been announced. They pave the way for the future of the hydraulic motor.

The new AX motors are available with displacements of 18 to 76 cubic centimeters per revolution [1.1 to 4.6 cu.in./rev], a maximum of 4,000 revolutions per minute and a continuous pressure up to 450 bar [6,500 psi].

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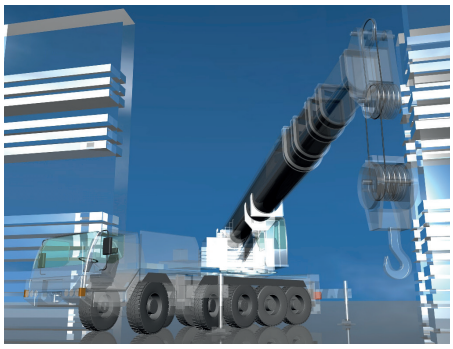

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