Electric Drives verses Hydraulic Drives in Carwash Tunnels

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I was recently asked a question at a carwash show about electric drives and devices in carwash tunnels and conveyor systems; and, if they represent a better technology over hydraulics. First, let me be clear; I have a vested interest in promoting hydraulics over electrics. However, I worked for many decades in the electrical/electronic industry in industrial process applications as well as 15 years in fluid power process applications. In short, whether electric or hydraulic, each has its place in industrial processes. In some cases electric drives are the better solution for applications whereas hydraulic drives are better for others. But, since the question specifically addressed carwashes; I think, we need to look at the application and then compare the two drive solutions.

The application involves the movement of equipment, vehicles, or in some cases both. Without getting into a lot of engineering, let's look at what we are moving and why. In the case of the traditional conveyor tunnel with soft clothe and brushes there are a limited number of mechanical functions that one needs to do in order to move the vehicle from the beginning of the process to the end. Beginning with the tunnel conveyor we have several choices.

The tunnel conveyor is a site attached system that is fairly simple in concept. Take an input rotary force; transmit it through a speed reduction gear; with the reduced output rotating some type of drive sprocket; thus pulling the conveyor and the vehicle. The input rotary force can come from any source; water wheels, pneumatic motors, electric motors or hydraulic motors. The conveyor mechanism will work no matter what drives it as long as the speed and torque are sufficient to ultimately turn the sprocket. Since water wheels and pneumatic motors aren't practical; we'll focus our attention on electric and hydraulic motors. A little history lesson; in doing my research for the article some early carwash manufacturers did attempt to use electric drives on the conveyors but encountered too many problems and finally settled on hydraulics.

Electric drives (motors) are an excellent means for converting electrical energy into mechanical energy. However, electric drives have poor power density. In other words; to get 5 HP of power out of an electric motor you need a large heavy piece of equipment. Since it is large in size it takes up more space and needs extra support when tied to the input of a reduction gear. In addition, the size is dependent on insulation ratings, cooling and NEMA/IP style and rating. Also, electric drives are dangerous in wet environments, water and electricity don't mix very well, and motors used in wet or wash down environments must be of special construction to keep the moisture out. In washdown or wet environments electric motors also tend to have heat problems and heat kills electrics and electronics. Most electric motors come at fixed speeds and operate best at those speeds. Variable speed electric drives require an expensive Variable Frequency Drive to control motor speed. Early carwash manufacturers attempted to initially use an electric solution to power carwash conveyors, brushes and clothe. They abandoned electric drives in favor of hydraulics for a number of reasons, but the single greatest reason was that hydraulics have higher power density and can be used around wet environments without fear of destroying equipment and most importantly "no shock".

Some electric carwash conveyor OEMs are promoting the use of electrics as a means of energy efficiency, lower energy consumption, and eco-friendliness. There is some truth to their claims but they are only addressing a small part of the overall energy use. First they are talking only about powering the conveyor; they are not addressing powering an entire system. Hydraulic systems traditionally power much more than just the tunnel conveyor. When all the other functions are brought in, including brushes, soft clothe and equipment positioning, the energy savings become only negligible and it's debatable what system, electric or hydraulic, is actually lower in energy consumption. To gain energy efficiency with the new style electrically driven conveyors they have moved to the newer technology of Variable Frequency Drives or inverter drive. A standard single speed electric motor needs a surge of power to begin rotation and build to speed. This surge can exceed 10 times the energy needed to run the motor at speed; thus, needing high energy available. What the inverter drive does is input energy in what is called a "soft start", only

putting in as much energy as needed to reach a certain speed; the speed is stepped until it eventually reaches the final speed desired. Also the inverter allows the motor to be run at an infinite number of speeds by regulating the electric frequency. It is a complicated piece of electric/electronic hardware and is expensive. Usually only the conveyor drive would be powered in this manner. Other functions such as tire brushes, other friction brushes and soft clothe would still be needed to be run by either individual electric motors, pneumatic motors or a combination of both. These electric motors would not be inverter driven because of the expense and would not provide any energy savings because of their single speed design. [*Let me address pneumatic driven motors and cylinders. Of all the possible power sources; pneumatic is the most expensive to run. Because of the compressibility of air it takes an inordinate amount of energy to achieve the working pressures required to do work. When comparing input energy to available work energy, most pneumatic systems only run at about 15% efficiencies. The idea that air is free just because a compressor is already installed is faulty. The only reason to use pneumatics is that it is good for high speed applications requiring only small input energy that will not damage vehicles because of non compressible forces, such as tire brush positioning cylinders.***] As far as electrically driven conveyors being more eco-friendly or "green", this is a true statement when compared to standard mineral oil hydraulic fluids. This is not the case when compared to the latest generation of carwash synthetic hydraulic fluids. I will address this more later on.**

Let's look closer at what it requires to run and maintain the latest generation of inverter driven tunnel conveyors. Since it is a highly sophisticated piece of equipment; the maintenance requirements are going to require specialized service personnel. Beyond the equipment warranty period; contact and contracts will have to be maintained in order to get routine service. Whereas, hydraulics are much less complicated and can easily be maintained by less specialized personnel. It is analogous to working on a 1960s model car verses working on a late model car. To work on the latest car models it requires highly trained technicians and special equipment. Any significant change in an existing carwash is going to require licensed electricians in the conversion process. Whereas, hydraulic system change, for the most part, can be accomplished by the owner/operator or one of their maintenance personnel. In existing carwashes are all of the function drives going to have to be changed in order to install an electric conveyor? If not, then you'll still be running a hydraulic system to power the brushes, soft clothe, etc. and only the conveyor will be different. Then their reason for eliminating hydraulics, which have low energy efficiencies and are not eco-friendly, will be self-defeating. If the concern is the amount of energy consumption and energy efficiencies with a hydraulic system, the true answer is to convert the hydraulic system to a high efficiency system by adding an inverter drive to the electric motor on the power unit. The only other change would be to install a pressure sensor in the high pressure line and feedback to the inverter and control inverter speed based on maintaining a constant system pressure. In that manner the non-variable pump will adjust with speed to meet flow demand while maintaining a constant working pressure. A further advantage is that none of the hydraulic equipment will have to be changed and efficiency has been achieved at a much lower cost than by partially converting the tunnel or converting the whole thing. The only thing that the owner/operator's maintenance personnel will not be qualified to work on is the inverter driving the power unit electric motor; all other things remain the same.

In new units equipped with electric inverter drives powering the conveyor, the costs will be significantly higher to purchase and maintain, without counting the cost of the hydraulic power unit. In addition, one will always run the risk of something going wrong and introducing electricity into the wet area. What is more dangerous; a hydraulic leak or electric shock? When units need to be replaced the replacement costs are much more expensive. For example; A 3∅, 5 hp electric washdown motor from a common supplier is around $700.00 whereas a hydraulic pump delivering 15 hp of force @ 1000 psi is only $200.00 from the same supplier. The electric motor would have to last approximately 3 ½ times longer to be price equitable. That isn't even an inverter drive rated electric motor, which can be even more expensive. Of course that is assuming the electric motor is a washdown motor. The OEM could pursue another solution and that is to use a standard inverter rated motor, non washdown, and enclosed it in an appropriately rated enclosure or space. This would add another dimension requiring concern over

keeping out the ingress of water into the enclosure. The other concern is, anytime that motors are enclosed, a concern over heat transfer. Electric motors produce a large amount of heat that must be transferred away from the motor and electronics. This is another possible trouble area.

Something that mystifies me is MacNeil Conveyors specification and claim on their RG440 series conveyor with 3 or 5 hp electric drives. They claim they are replacing either a 10 hp or 15 hp hydraulic motor. What doesn't follow is if it only takes 3 to 5 hp to operate the conveyor, why would it take 10 to 15 hp if it's a hydraulic drive. Horsepower is horsepower, no matter the source. Now they may be indicating they are replacing a 10 to 15 hp power unit, but that's not the same as needing 3 to 5 hp to drive the conveyor. If it only takes 3 to 5 hp to run the conveyor then that is how much the hydraulic motor will provide, even though it may be capable of providing much higher power. The 10 to 15 hp power unit is usually also powering other hydraulic motors and cylinders. If one were to add up the 3 to 5 hp conveyor motor with other drives needed for the brushes and soft clothe drives, it can easily equal 10 to 15 hp in total. I think they need to clarify there specification. As it is it could be misleading. I can only assume who made the marketing piece is not well versed in basic fluid power engineering or power dynamics.

As promised I will now address the leak issue. A continuing problem with hydraulic systems is that they have the potential of leakage. This is particularly problematic in carwashes when the fluid gets on the vehicle's surface and in the brushes and soft clothe. Mineral oil hydraulic fluid is the primary culprit. When it gets on the vehicle surface it requires time consuming hand washing to remove it. This is not only time consuming but causes expensive downtime, let alone causing problems with the affected customers. Getting the oil out of the brushes and soft clothe requires shutting down the system and extensively cleaning. In some instances to get the system back up more quickly some operators simply change the contaminated components. The tunnel has to be cleaned which also requires an extensive shutdown. However, during the mid 1990s Pinnacle Solutions introduced Aqua Blue water based hydraulic fluid. This eliminated all the problems when a leak occurs. The water based fluid can be simply rinsed off the vehicle's surface with fresh water and the brushes and clothe can equally be rinsed off. Also the tunnel surfaces can be rinsed with water. The water based hydraulic fluid doesn't harm the water reclaim systems either. As far as eco-friendliness is concerned the water based hydraulic fluids are "readily biodegradable". These characteristics that all water based hydraulic fluids share; but, MRL HYDRAULICS is now providing a 3rd generation water based carwash hydraulic fluid called ENVIRO-GREEN II®. It is even more biodegradable and its base is manufactured from a renewable resource, making it even more eco-friendly. This product is less expensive than other water based carwash hydraulic fluids and also contains "Leak Spotter"™.

Although hydraulics and electrics each have their own place; the use of electric VFD in carwash tunnels is an expensive and overly technical solution to solve the problem of leaks and doesn't present the best solution. It is simple overkill. If overall efficiency and power consumption is a concern for the hydraulic system, then adding a VFD to the power unit's electric motor will do the job with a minimum of effort. This doesn't require the changing of anything else. With the latest generation of water based hydraulic fluid from MRL; the electric conveyor's arguments have all been answered for a great deal less. The only reason to continue to argue for the electric driven conveyor is that many of their previous customers are now manufacturing their own hydraulically driven conveyors and the conveyor OEMs offering electric drives are attempting to recapture the lost business with a product the industry doesn't want or need.

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