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JSG ELEVATOR CONSULTANTS, LLC

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His education and experience combined with his former position with SD Myers as director of western operations. S.D. Myers, a nationwide oil testing and reclamation firm providing testing services to major industrial and utility customers in the US. This experience makes him uniquely qualified to promulgate this proven testing technology and maintenance concepts to the elevator industry.

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Oil Testing Technology and Hydraulic Elevator Benefits

Industry Forecast

By Frank Fletcher & Michael Fagan
JSG Elevator Consultants

The demise of the hydraulic elevator was forecast with the introduction of the MRL traction elevator about 20 years ago; In spite of this new design conveyance, the hydraulic elevator is again beginning to thrive in the US market. The threat of replacement by the MRL traction elevator is now waning. Hydraulic elevators are still viewed by many within the industry as the best selection for many buildings, in most applications for travel of 50 feet and less, the hydraulic elevator will perform as well as a traction elevator. However, speed and travel is a limiting factor

With new cylinder and well hole designs. the hydraulic elevator is expected to last longer than ever. The environmental risks and concerns are lessened with the encapsulation of the cylinder and the use of the cylinder liner and bulkhead. The initial construction cost is less than an MRL alternative. The operating costs are less than anticipated.

Points of View:

Construction: The conventional hydraulic elevator installation usually sells for about 35% less than the competing design MRL Traction elevator.

Energy: The pump motor in a hydraulic elevator is only energized when the car is running in the up direction. When the car is in the down direction only the low voltage solenoid valve is energized, resulting in a virtual zero cost to operate.

Preventive Maintenance: Hydraulic elevators are usually less costly to maintain. A typical four stop hydraulic elevator costs about 25% to 30% less per year for a "full maintenance" service when compared to a traction elevator.

Now let's look at a maintenance service program for a hydraulic elevator from the service contractor's point of view. What starts off as a good deal for everyone, begins to sour. Even when the contractor receives an increase in the service price each year, the aging equipment, deterioration of the oil and need for frequent parts replacement causes increased callback and repair time. This cycle begins to erode the profit margin of the contractor along with the customer level of trust and satisfaction.

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Call Back Maintenance: (Hydraulic and Traction) In fact, this service area has become an additional revenue stream for the contractor when service call backs are not covered by the service contract, or the overtime portion is billed to the customer. To some contractors, increased unscheduled callback time is not an additional labor cost because the route mechanic is expected to complete the route service along with callbacks responded to during the month. To meet the demand of service calls on the route the contractor has to allow sufficient time for servicing the elevator. This flawed concept results in frustrated mechanics and added revenue for the company. The company still receives the payment from the customer. However, the many negatives of methodology are hidden in the form of opportunity costs to the owner and contractor. What is this doing to the contractor's overall reputation? What about the degradation of the equipment? These are real costs, consider why the rental car industry services their vehicles every time they are returned.

Litigation Cost: Under the "call back" service program noted above; how many liability claims is the contractor forced to defend against claims for improper operation of the elevator? This methodology has resulted in increased litigation and liability insurance costs for the contractor and industry.

M**aintenance Control Plan (MCP):** A program modeled after the automobile and aviation service standards. There are many new service technology ideas for keeping an elevator in top operating condition. so how do we deliver this to the customer? The issue is delivering adequate service time to perform the good maintenance protocols. The ASME A.17.1 2013 Code for the Maintenance Control Plan (MCP) is emerging as the new standard for prescribed elevator maintenance. The program includes the details for each service task to be performed. The programs are available for both owner and contractor.

Points to Ponder: How much more effective could a technician be when servicing accounts with fewer callback interruptions? How much better quality effort could be delivered to the customer when a service visit takes place? How would the public perception of the service contractor be with their fleet of elevators operating efficiently, and without noise, leveling and reliability issues? How predictable would the replacement of parts be? Accurate predictions would result in more efficient and reliable uptime. Would reliability command a premium service price in most hydraulic and traction markets? The MCP program can produce a higher level of customer satisfaction. The contractors that are looking for 10, 20 years plus, or; "lifetime" contracts can realistically offer this custom service program to premium clients.

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New Ideas for Hydraulic Elevators: When we get to hydraulic elevators; there is one service method technology the industry is beginning to find acceptance in. This is the preservation of hydraulic oil in elevator systems by using periodic oil testing, analysis and filtration. What we have to understand is the aging and degradation of hydraulic oil creates havoc within the hydraulic system. Managing and controlling the quality of the oil brings under control several variables affecting the total hydraulic cost equation.

The greatest consumer of oil was the internal combustion engine and where most of the oil conservation efforts concentrated. The efforts resulted in a significant savings of oil, along with the added benefit of cleaner air for the environment.

After the oil industry and science addressed the automotive industry, more challenging applications were then confronted. The aviation, marine, industrial, power transmission, and turbine industries were subjected to close analysis. One by one, the standards and usage for each industry were examined and refined.

When looking at the common oil usage in all the above applications, we arrive at some basic understanding and functions of oil:

1. Lubrication – Reduction of friction in moving parts, thereby extending the life of those parts.
2. Transfer of heat – Keeping moving parts cool.
3. Transmitting force – Such as used in a hydraulic system for power assisted mechanical equipment.
4. Providing dielectric strength – Normally used in electric power transmission equipment.
5. Preventing corrosion – Example: Cleaning and oiling weapons during military service.

A reduction in the volume of oil in a system has minimal effect on these except for *Nos. 2, Transfer of Heat and 3, Transmitting Force*. Since the early 1960's most of transportation, industrial, marine, aviation, power transmission, and turbine equipment has the benefit of operating with more efficient engineering of hydraulic system designs employing less oil and higher pressures.

To keep equipment operating efficiently and protect capital investment, industry related owners and managers were compelled to improve the quality of maintenance programs. Oil testing and analysis programs were developed to determine the relationship of wear on the equipment and degradation of the oil.

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The research and results revealed that oil really does not wear out. It oxidizes and becomes contaminated with impurities, and creates organic compounds namely acids and sludge material. The acids formed are most commonly Acetic, Formic and other long chain acids. This contamination in the oil attacks the interior workings of the hydraulic system. The sludge formed reduces the heat dissipation properties of the system, and further accelerates the acidic reaction within the oil. When the impurities and oxidation by products are examined; an estimate of the degradation of the subject system can be developed. Additionally, oil analysis can be used to identify the system component, degradation and other wear from the oil contamination taking place. Those impurities in the system can be filtered and removed, spent additives and oxidation inhibitors reintroduced, and voila! … A new batch of is oil ready to load for another life cycle, and importantly the testing results provide a baseline diagnosis of the health of the equipment for future reference.

The Elevator Industry: Oil testing technology has finally arrived at the elevator trade. In this conservative industry technology lags by 10-15 years behind other industries. Given the reliability required to keep the riding public safe, new technologies are only introduced when thoroughly studied and considered safe.

Elevator manufacturers now design equipment with high operating pressures and reduced quantities of oil in hydraulic power units to control cost, and space. The result of these designs is the hydraulic system must work harder at removing heat, transmitting force and lubricating the components in the system. With all three of those factors noted; the hydraulic systems are frequently showing signs of premature oil aging, contamination and degradation.

One manufacturer produced a chart with the operating range for their power unit not to exceed 185 degrees Fahrenheit. This is the upper range of satisfactory oil temperatures. The operating temperature of oil is critical in this equation. The main catalyst that starts the process and speeds the aging process in hydraulic oil is the elevated operating temperature.

Another key ingredient in the mix is moisture from atmospheric condensation. Moisture is not only an accelerant in the aging process, it can by itself compound the problems in the elevator. However, nothing creates deterioration of hydraulic oil faster than oxygen combined with excessive heat in the system. Exactly as found in other types of equipment noted above the acids and sludges Over time hydraulic oil will mix with oxygen in the atmosphere and begin to form organic acids in the oil. In electrical power transmission equipment, the oxygen degradation process is delayed by pressurizing the tanks with a blanket of dry nitrogen gas, this inert gas is suspended on the top of the oil. Elevator oil reservoirs are not pressure sealed and allow air with

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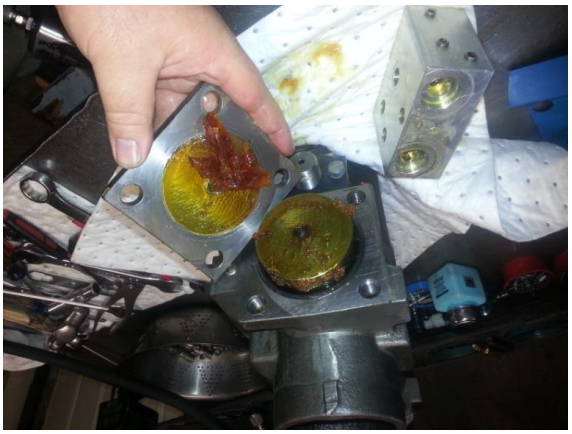
oxygen to freely mix over time with the hydraulic oil in the reservoir. This mixture causes the oxidation process to occur. The by-products of oxidation are acids that attack the various types of flexible seals used in the hydraulic system. These include the organic materials like rubber found in the mufflers, and the O rings in main control valves. This exposure causes synthetic and rubber seals in the system to lose their flexibility and become brittle. It also creates rust on metal components in the system. Worse yet, the sludges produced as a by-product af overheating acts as insulation, thereby reducing the heat dissipation of the reservoir holding tank. The contamination also causes micro pitting of milled and polished metal surfaces by corrosion of the pump and valve components. This results in a reduction of the lubricating properties of the oil when degradation is not detected and properly managed.

Decomposition of muffler disintegration from oil that is found migrating into the operating valve.

Sludge/varnish deposited on inside of tank and also found in the operating valve

Vegetable oil residue (sludge)



Vegetable oil residue (sludge)

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Sludge occurring in the hydraulic system will hold water suspended in the oil, also as mentioned, it becomes an accelerator in the degradation process. This water is not observable as free water in the system, it is dissolved and a colloidal suspension of H2O within the oil itself. A side effect of water in the oil, it reveals itself as a ride quality issue Ex. "sponginess" or bouncing of the car can be observed by passengers of a hydraulic elevator.

Now we have identified rubber particles, acid, rust, varnish and other contamination along with water and oxygen suspended in the hydraulic oil. How often do these contamination issues result in frequent leveling and operational problems? How often is blame placed on the operating valve as the cause of the problem? The contractor replaces the valve, or spends repeated time on call backs trying to adjust the valve, unaware the real cause is the contaminated oil varnish and particulate matter found in the valve body? Finally, and not to be forgotten; what about the cylinder packing replacements and flooded oil in the pits?

Now that we know all of this, what can we do? What is the point? As technicians, not scientists, we are willing to postulate that the hydraulic system components of an elevator, if properly maintained, monitored and serviced, with an operating temperature of say 95 degrees, and motor protection, should operate reliably for 30-50 years with *NO* major components needing replacement. That's not to say an upgraded improved controller can't be added. Here we are talking about the "bones" of the elevator, the hydraulic system.

Oil Management: A good hydraulic oil testing and reclamation program can make the equipment last longer and perform more efficiently. This in turn will help control the maintenance contractor's labor and parts overhead and profit margin while properly maintaining the equipment.

For the record; let's begin to think of the MCP as "*Asset Management*" rather than the misnomer a preventive maintenance program. The result can be a successful service program. Not just a win for the service contractor, it can be a win for the owner too. If a typical hydraulic elevator installed today, we might replace the controller and minor components in say 15-25 years. The pump motor when protected with an electronic soft starter should also last for 15-25 years without a major incident or longer depending on usage.

The hydraulic elevator system, when properly serviced and oil preserved, should theoretically remain intact except for minor repairs. The main hydraulic control valve when kept clean filtered uncontaminated oil, should be able to withstand 25 years and countless cycles of use. This reliability combined with in ground hydraulic cylinders enclosed in a protective PVC sleeve and isolated from corrosion and electrolysis, oxidation and ground water contamination.

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The hydraulic system can provide reliable service well beyond 25 years. We might go further and ask; just how long *would* a hydraulic elevator last if the door system hardware is also properly maintained and repaired along with the hydraulic system and controller? 25-50, maybe 75 years? Why not?

Considering regular systematic visits by a technician in a managed asset protection plan and MCP. The service contractor should be able to calculate a predictable component failure rate and scheduled replacement plans that reduces exposure to the uncertainty of faulty operation and subsequent litigation costs. Improved reliability and predictability will also provide more consistent and predictable profit margins. In short, a lifetime service program that is mutually successful for the buyer and seller.

Conclusion: In summary, an aggressive oil testing and reclamation program for hydraulic elevators refurbishment is destined to become the industry standard within the near future. The factors as presented here and combined with elevating the contractor's reputation makes it an attractive methodology. The service price/profit motive of this technology in the elevator industry will become more accepted as industry education and trades acceptance takes place.

Energy savings and minimal space requirements are often the driving point for purchase of a traction elevator. These are often considered but miss being properly compared with the initial construction prices and continuing service program costs that should be factored into the equation. The overall financial benefit of the hydraulic elevator can add up to a significant amount over the long term, for all involved.

The demise of the hydraulic elevator has been greatly exaggerated!

In the long run; the hydraulic elevator is here to stay!

Submitted by: Frank P Fletcher & Michael Fagan
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Notes From:
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