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Energy efficiency of the hydraulic lifts – Reality and perspectives

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Introduction

The hydraulic lifts are particularly popular in our country for a key reason, which is the existence of average height buildings in the majority of Greek territory. In reality, the installation cost of hydraulic elevators is lower over the mechanical ones, for buildings up to six storeys and this is the main cause that most buildings in Greece have hydraulic lifts.



Hydraulic lifts are advantageous in many aspects over mechanical lifts, but inevitably all comes down to the cost, where the hydraulic elevators outweigh by far. Nevertheless over the last years an awareness concerning the energy saving and the carbon footprint of all installations has risen and as a natural effect the lift installation of any construction is now evaluated from that aspect as well.

At first glance, the hydraulic elevators are more than enough impaired against mechanical ones at their energy levels, mainly because of their installed capacity and power consumption. This is mainly due to their operating principals and one might invoke that it is "a psychological disadvantage" that does not fully reflect with the reality. This is easily understood if we consider that although a hydraulic lift usually requires three times the power levels of a mechanic one, on the other hand, this power is consumed only during ascent and not during the descent of the elevator.

Is of interest, therefore, to focus on the facts in detail, as well as the current developments in this field, in order to discern some important points, which may appear as “environmentally friendly” disadvantages, but, if we gain insight to this, we will surely conclude that the energy consumption of a hydraulic lift is not higher than this of a conventional mechanical lift.

It is commonly known that the weaknesses of the hydraulic lift are distinguished in two energy consuming points: These are the losses by the variation of speed during the ascent and the overall efficiency of the conventional power units.

A. Losses caused by the speed variation during ascent.

In every hydraulic lift, operating without an inverter, throughout the acceleration sequence, the constant velocity motion and the deceleration, the pump of the lift consumes the maximum required power only during the ascent. This is caused because the chambers velocity keeps building up or reducing with a steady pace, the pump supplies constantly the full amount of its supply (therefore also the motor) and the portion that excesses is returned back to the tank transfigured as heat. The amount of the energy lost depends on the acceleration and deceleration times. These durations are mostly depended on the nominal speed of the lift, since the approximate speed rate for means of comfort is usually stable. In reality this means that the higher the velocity of a lift, the higher the loss in energy is in every acceleration and deceleration.

The only solution to the previous mentioned problem is: the use of VVVF inverter. With the use of the VVVF inverter, one can accelerate the lift consuming only the power needed, without the losses of the conventional valves. The basic choice the inverter provides is the motion control within reasonable acceleration and power limits, if such an issue presents itself with the electronic installation of the lift. In order for the inverter to being used for the control of the lift, a completely different type of control valve is being needed, as well as many other factors that need to be taken into account. Foremost is the volumetric efficiency of the pump.

By parallel connection of the pump and the clutch between the motor and the oil, the volumetric efficiency is in fact in reverse proportion with the energy loss. The losses of the pumps which are widely used in the hydraulic lift system industry are of importance and depend on the rotation rate of the motor. This proves that even the direct rotation control of the motor does not provide a satisfying prospect for the chamber's speed, because operating lower than a speed limit, the pump does not function. The alterations that have been submitted for a dependable control in the chamber's movement differ and they are mostly involved with the flow control of the oil. Despite the fact that the use of a chamber sensor provides with the absolute control of its movement, the development of systems that measure the flow with the compensation of the temperature provide a equally effective, but more dependable measure.

The use of the inverter, as it has derived from experimental results, can induce in energy saving up to 60% in frequently used elevators. Because the energy saving is of importance, it is not uncommon that complete solution, with minimum impact on the power unit and the panel, in alternating a conventional system with one that accompanies an inverter are offered. From a financial spec, a modification such as mentioned above can write off the cost in less than 3 years. For example, the well known German company Blain Hydraulics GmbH, having on its record several hundred thousand typical valves in use globally, has been planning such a type. It is known for the ease in replacement of a plain valve and is accompanied by inverter of the company Yaskawa, which include a specialized function for hydraulic lift systems.

The energy saving in this way in many occasions resolves another effect of the hydraulic lift. That is the overheating caused by the oil in elevators with frequent use. The lifts that face that problem operate massively and in that cases the maximum energy saving occurs. In a full circle of motion of the lift, the energy consumed during the engine operation eventually mutates into heat. It is therefore clear that the less energy we consume, the lower the oil temperature remains. The usual solution to this problem was the placement of an oil-cooler device. Given the fact that the energy conservation in a frequently used lift reaches up to 60% and the cost of an oil-cooler is of the same level as the placement of an inverter, we can easily come to a conclusion that the modification can make up for its cost in a short period of time.



B. Efficiency rate of the power unit

Over the past 40 years a lot of facts have been changed in the hydraulic lift industry, but others remain the same. It is worth mentioning that the pair of the submerged motor and the screw pump has been the reference point in the last decades. The main reason why this combination has been so popular is on the one hand the low cost of it and on the other, its low level of noise.



The placement of the engine into the oil has the advantage of the direct cooling of it. Taking into account that the motor operates for a limited amount of time and with staging spaces larger than the service intervals, meaning in a duty cycle S4, then we have a motor that is extremely economic, but also trustworthy. As an indication, the cost of a submerged motor of 30 HP is relevant to a conventional motor of 10 HP. The down effects of such

application are caused again by the oil. The hydrodynamic friction of a rotor that operated at 2800rpm within the oil is a major factor. The use of oil as a cooling measure raises the temperature further, not only by the energy produced within the duty circle, but additionally from the friction produced. This results in an extremely low efficiency rate of the motor, which accompanied even with the most modern techniques applied, does not overcome 82%, that is still 10% less than the up to date external EFF2 motors.

The screwed pump is very inexpensive, even for the highest supplies and has an extremely low noise level, compared to the plain hydraulic system pumps. The use of the screw pump in the hydraulic lift systems appears to be a one-way-street, even today. Moreover, in the last period of time, external high performance motors are promoted for the use of screw pumps. Of course, this solution sounds rather absurd, if we take into account the efficiency of a pump, which at its best can reach 75% efficiency. This performance is extremely low when compared to other types of pumps and thus appears to be a major disadvantage. Nowadays, due to the progress of mechanical, physical metallurgy and fluid mechanics, we have at our disposal high performance pumps, with over 90% efficiency, and with low noise rate. Of course, the cost of such pump is multiple compared with a screw pump.

Evaluating the total efficiency rate that the regular combination of a submerged motor with the screw pump has, we reach at tops the meager $0,82 \times 0,75 = 0,615$ or 61,5% efficiency. By the usage of a conventional high efficiency motor and the relevant pump, we can achieve $0,92 \times 0,92 = 0,85$ or 85% efficiency. As is easily understandable, such a solution has at least 38% greater performance, a very significant improvement. Apparently, the total cost of such solution is quite higher, but as always, it is returned by the energy saving.

Conclusion

Surely, there are many prospects of further improvement regarding the performance of the hydraulic lift. The use of inverters and the use of high-performance motors and pumps, can lead to impressive results. Already, many applications with all the improvements mentioned above, which are pointing to the right direction, have been implemented. No doubt, the extra cost of such installation is an important factor and the depreciation time depends on the use of the elevator and of course, the cost of energy.

In Greece, this type the applications are minimal and they are mostly chosen because of the low installed power, rather than the energy saving. In Northern Europe, however, these solutions are not considered as «sophisticated», since the energy cost is in much higher levels and the eco-consciousness awareness of its citizens is deeper, so the extra cost is accepted.

Everything indicates that this will be the future of the hydraulic lifts. As the years pass, the low energy solutions are being taken into more account. The eco-friendly advantages of the hydraulic lifts will become more distinctive, whether examining the whole hydraulic lift system of any installation, or individually each factor.