
Why hydraulic elevators are so popular? Part I

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Key Words : Hydraulic Elevator, Elevator Market, Elevator Safety.

Abstract

Hydraulic elevators have dominated the elevator market for 50 years until the beginning of the 21st century. With the emergence of machine-room-less (MRL) traction elevators in 1995, hydraulic elevators are dealing with increased competition. Nevertheless, fluid driven systems have their distinct advantages, such as low maintenance cost due to wear free driving components, flexibility of car and machine room design, superior safety features, easy and cost effective installations.

The proclaimed room saving properties of MRLs initially have generated increasing numbers of MRL applications, however this shouldn't be interpreted as a decreasing market for hydraulic elevators since the facts are that hydraulic control valve production is increasing yearly. As hydraulic elevators and their advantages become better known in the developing countries, the increasing trend to MRLs is expected to level off. The future of the elevator systems may become certain as their advantages and genuine costs become public.

This article presents statistical information on the actual elevator market trend for low-rise buildings.

1. Introduction

Since the 19th century, cable elevators as well as water hydraulics were used for vertical transportation. In 1950's, oil hydraulic elevator solutions were introduced in the U. S and in Germany at about the same time, and quickly became popular. Initially, hydraulic elevators were used for vertical transport of general freight (excluding passengers) and over time, due to improvements in valve controls and economic reasons, hydraulic elevators started being used for transferring passengers. The economic reasons that favored hydraulic versus traction included the cost of hoist-way construction, equipment and labor required for installation.

According to the statistics by the National Elevator Industry, Inc. (NEII), companies produced more hydraulic elevators than either geared or gearless traction elevators in 1970's. In 1973, hydraulic elevator production overtook the total traction production, more than doubling that of traction elevators each year since the mid 1980's. In 1986, approximately 70% of the all elevator units sold for new buildings in the U. S. were of the hydraulic type. Hydraulic elevator production until the year 2000 remained at three-to-four times that of traction elevators. These statistics are only for the NEII member companies. Certainly many more hydraulic elevators have been installed by non-NEII member companies throughout these years [1].

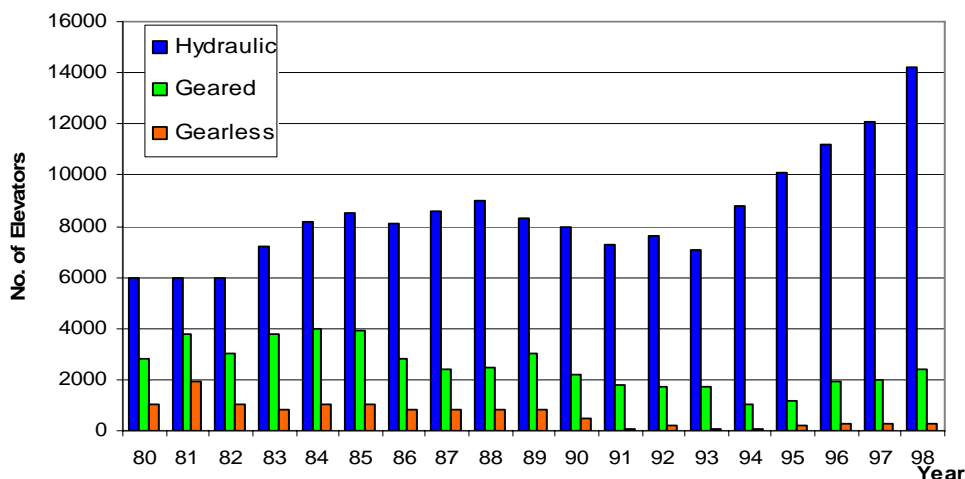


Figure 1. Elevator production between 1980 and 1998 in NEII member companies [1].

Since 1995, major elevator companies have released a new drive system, directly targeting the low and medium-rise market. The new system is known as machine-room-less (MRL) system. It implements Permanent Magnet Synchronous (PMS) motor technology that eliminates the speed-reducing mechanism, resulting in the reduction the weight and the size of the traction machine. With this solution, the machine and in some cases, the control are placed inside the shaft thereby eliminating the need for a separate machine room. Hence, architectural flexibility of the building is improved. The energy saving is achieved by eliminating power consumption from the worm-gear transmission. Among its further advantages, compactness, lubrication-free design and high torque at low speed can be counted. Although using PM materials increases the manufacturing costs of the motor, the elimination of the gear transmission mechanism is said to balance the increase [2].

On the other hand, the cost of traction MRLs are still higher than the hydraulic units. It is believed that in time, the manufacturing volume of MRLs will increase and the cost will go down, increasing the competitiveness of MRLs. [1].

However, hydraulically-operated elevators have established a very strong market position with their high level of safety, easy installation features and service free-running characteristics. Figure 2 shows yearly percentage repairs of hydraulic control valves (received from customers) at Blain Hydraulics GmbH, which is a major control valve manufacturer. It can be seen that the total repairs received is at most 0.087 percent of the total valves in operation (350,000) in 2003, 0.037 percent of which are attributed to mishandling of the valve (dirt inside the valve, wrong adjustment, wrong assembling after servicing, etc.). These numbers are 0.037 and 0.028 in 2005 respectively. Having such a small percentage of failures for the key element of the hydraulic system suggests that the hydraulic elevator systems have standards of reliability which are unequalled by traction systems.

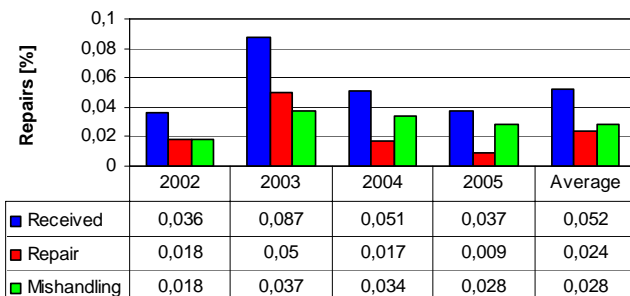


Figure 2. Percentage total repairs and mishandling (Taken from Blain Hydraulics).

As competitors, MRL manufacturers have been trying to reduce the popularity of hydraulic elevators by introducing two arguments as drawbacks of hydraulic elevators. These are the energy

consumption and the environment concerns. These arguments, which will be discussed in the next paper, are mainly brought by traction elevator manufacturers, while there are practically no complaints from end users. Understandably, such general statements and critical remarks against hydraulic elevators are aiming to increase the market share of MRLs by any means.

2. The elevator market

Large numbers of elevator installations have taken place in the developed countries. The majority of such countries have considerable numbers of low rise buildings, apart from those who have limited land space and large populations. In such countries, the hydraulic industry had also advanced, with high quality hydraulic elevator control valves, pumps, motors, jacks and other related equipments, available at low prices. In addition, the outstanding advantages of hydraulic elevators also persuaded elevator companies and constructors to choose hydraulic drive units for their applications. There was also a public awareness of comfort and safety, which made the hydraulic type more favorable. As a result, hydraulic elevator installations were over 60% higher than the traction elevators worldwide (Figure 1). This trend changed around 1995 as traction MRLs were introduced into the low-rise market.

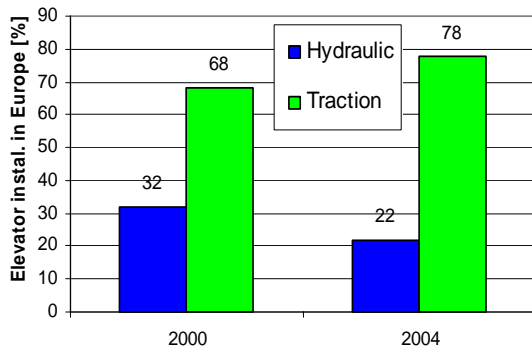


Figure 3. Percentage elevators installations in Europe [3].

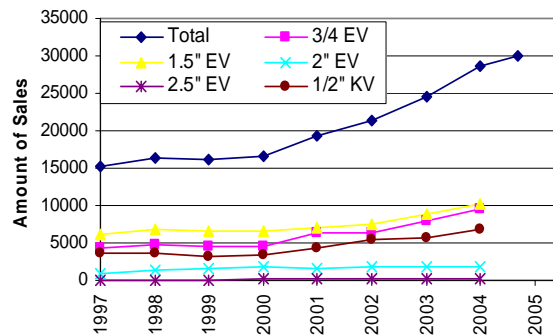


Figure 4. Increasing trend in control valve production.
(Taken from Blain Hydraulics).

The advantage of having no machine room is much appreciated by civil engineers and architects, and the number of MRL installations has increased in a short time. The reputation of highly regarded multinational companies is another reason for general acceptance of traction MRLs. Reports reveal that the share of hydraulic elevators has reduced to 40% worldwide, and in year 2010 two thirds of new elevators are expected to be MRLs. The statistical results for Europe in years 2000 and 2004 are shown in Figure 3 where, the rough data for Greece has been up-dated[3]. According to the statistics of year 2000, 81% of elevator installations in the U.S. were of the hydraulic type [4].

However, the situation of the hydraulic market is not as serious as it would seem. This is shown by the requirement for hydraulic control valves for elevator installations increasing each year. As an example, Blain Hydraulics produced 72 percent more valves in 2004 than 2000 (see Figure 4). There may be more traction installations than hydraulic ones in coming years, but this doesn't prevent the yearly increase in hydraulic installations. With time, as the advantages of hydraulic elevators are acknowledged in the developing countries, the ratio of hydraulic to traction installations can be expected to stabilize.

Surprisingly, in an industry that has prided itself on its safety records, with the introduction of the MRL elevator, major companies have sacrificed the safest elevator constructions in order to gain economic control of low-rise elevator installations. To favor this behavior, safety codes are being changed to relax the requirement for a secure machine room. Most people are not aware of the risks that may result from the code changes. Hopefully, the unnecessary risk being taken will be recognized before there are serious consequences.

Aiming to improve competitiveness, hydraulic elevator manufacturers have also developed MRL solutions, intended to remove the necessity of the machine room [5,6], allowing the power unit to be located inside the shaft, in the pit or within a landing-door assembly. When MRL applications are compared with regard to safety, hydraulic MRLs suit better to applications that omit machine rooms than are traction MRLs. This is because, with hydraulic systems, all operations are carried out directly in the pit or at the lowest landing door for both the ease and the safety of the installer. In contrast, electric installations require maintenance on the cabin roof of the elevator with machines placed in the potentially unsafe upper part of the hoist-way.

3. Situation in Europe and in Turkey

Figure 5 shows “Existing Lifts/Employees” ratios for various countries in Europe for the year 2004. In Turkey, the ratio is half of the European average. This can be interpreted as the competition in the market is more challenging in Turkey in terms of number of competitors. The next figure gives the percentage of elevator installations in Europe in the same year. From there, it can be seen that the European market is dominated by traction MRLs except for the markets of Turkey and Greece. The highest number of elevator installations in Greece is hydraulic type (approximately 85%), whereas the traction type with machine room dominates (80.4%) in Turkey. The hydraulic and MRL elevators are 12.9% and 6.7%, respectively, in Turkey.

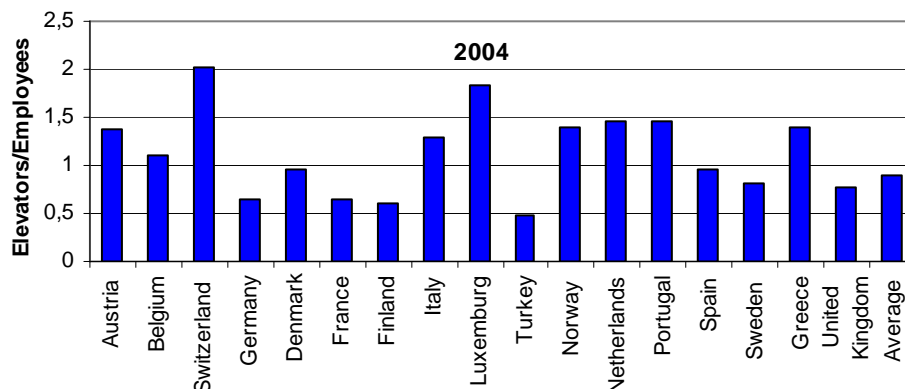


Figure 5. Ratios of elevator installations to number of employees in Europe [3].

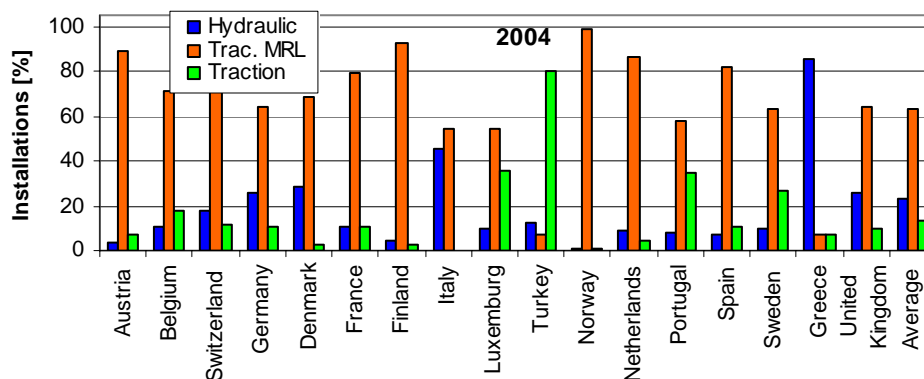


Figure 6. Percentage elevator installations in Europe for the year 2004 [3].

The building stock of European countries is generally mid and low rise. As the multi-national companies have become stronger in the market, particularly with patented MRL systems, small and middle-sized companies have lowered their prices to stay competitive. This resulted in price cutting in the market followed by the multinationals' strategy of taking over small and middle-sized companies in order to dominate the market. Presently, the multinationals offer very competitive prices for new installations, on the bases of obtaining service contracts and selling spare parts. Maintenance is seen as the hen lying golden

eggs by the multies. Their strategy is that if you cannot earn much from the initial sale, you do so during the maintenance [8]. As a result of their marketing strategy, 75% elevator business in Germany is shared between a few multinational companies, and the remaining 25% is shared by approximately 400 small companies, which are mostly in the servicing sector. If this trend grows, there will be no room in the market for small competing companies, which normally serve to keep prices reasonable.

In Figure 7, valve sales for various countries are indicated in percentages. From there, the current situation in Germany can also be clearly seen. Valve demand in Germany is decreasing due to the expansion of MRL applications. However, other countries show, in general, stable trends. Most valve sales are made to Greece and the U.S.

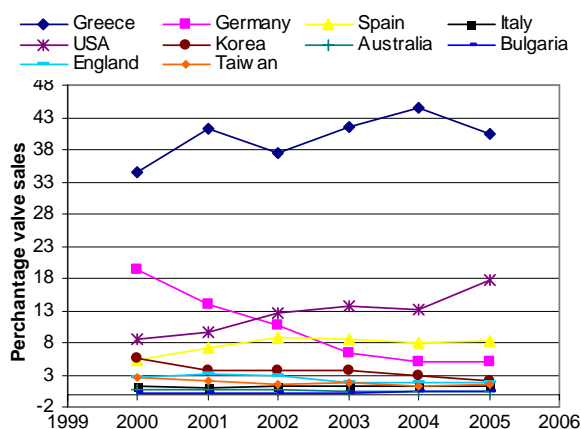


Figure 7. Percentage control valve sales to various countries. (Taken from Blain Hydraulics)

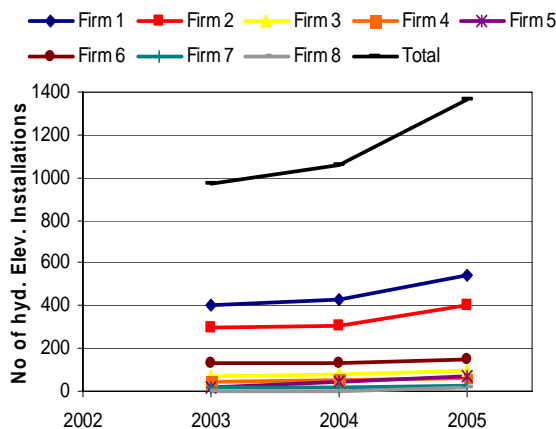


Figure 8. Number of hydraulic elevator installations in Turkey.

The situation in Turkey, which may have similarities with other developing countries in the Middle East and Far East, is at the moment more challenging for the multinationals to grasp the elevator market easily. In developing countries like Turkey, the use of elevators is increasing as the building quality advances. There is a large number of elevator and component manufacturers as well as servicing firms, the majority of which deal with traction elevators with machine rooms. Many of such companies are small with a few employees and have a limited financial and technological foundation. Though elevator systems or equipments of such firms may not keep up with the elevator code, their low prices attract building constructors and owners. Rumors of such firms, being awarded International Organization of Standardization (ISO) and Conformite'Europeenne' (CE) certificates is appropriately a matter of concern. Existence of undeserved certificates affects the competition in the market, creating huge price differences between the low- and high-quality products. On the other hand, since the customers are usually unaware of the most suitable elevator system for their needs, price of the elevator system becomes a crucial factor in making their choice.

The hydraulic elevator is generally an unknown factor in Turkey, and therefore too few constructors recommend hydraulic elevators. Lack of competent hydraulic engineers and technicians in the elevator industry has big consequences on hydraulic elevator installations and servicing. It is easier and requires little expertise for small companies to construct inferior traction elevators with which they are familiar, without considering better alternatives. Such behavior comes from lacks of knowledge and comprehension of the advantages of hydraulics, which generally have a better price/performance ratio than tractions. The popularity of hydraulic elevators in Turkey is nevertheless increasing steadily. Figure 8 shows annual sales records of 7 major hydraulic elevator manufacturers in Turkey, which indicates 29.3% increase in hydraulic elevator installations in 2005 with respect to the previous year.

Meanwhile, the multinational companies are expanding in the Turkish market with their MRL solutions. Their prices are still high for the Turkish market in comparison to the hydraulic and traction elevators. At

present, under such conditions multinationals are not competitive with MRLs. Nevertheless, it shouldn't be forgotten that their proven marketing strategies and ability to influence the codes may lead to increase risk factors in an increased number of installations.

Unsafe solutions should not be allowed in vertical transportation systems. MRL manufacturers itself accept the fact that placing the machine in the shaft, either in the pit or in the headroom, is a conditional safety solution [9]. MRL solutions may perform safely under some specific conditions however, it is better to remember that they are being used under differing circumstances. The most dramatic situation occurs when such unsafe elevators are permitted in seismic regions. Hanging the machine in the shaft would not guarantee that it withstands seismic movements without falling. (In the previous paper, a comprehensive study on suitability of different elevator types in the seismic regions was presented [10]). For instance, 93 percent of Turkey is in the active seismic zone and 98 percent of the whole population is under earthquake risk. According to the statistics (State Institute of Statistics in Turkey, www.die.gov.tr) 97% of the total number of buildings in Turkey has 6 floors or lower. The total number of new buildings with number of floors through years according to the occupancy permit is shown in Figure 9. It can be seen that the number of buildings are decreasing through the years, and the amount of high buildings (6+) are having a lower ratio each year. In recent years however, the increase in high building constructions in seismic regions is another conflict against safety.

Under such seismic and building stock conditions, trying to promote traction MRL not only causes more fatalities during natural disasters but also brings more damage and renovation costs due to the hanging car and the counter-weight in the shaft. Elevator companies are aware that the consequences of earthquakes on traction lifts are far more dangerous than their consequences on hydraulic elevators. They are also aware that assisting trapped people to escape is far more difficult, for ordinary citizens to accomplish in the case of MRLs. MRL manufacturers should therefore be made accountable for the unnecessary exposure of the public to life and limb.

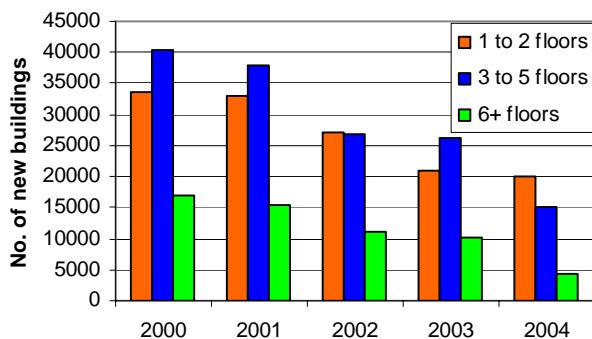


Figure 9. Total number of new buildings and number of floors according to occupancy permits [12].

It is a major responsibility of elevator code makers and all elevator related authorities to promote safer elevator systems. Future catastrophes will have greater or lesser consequences, depending on their decisions.

8. Conclusions

Although the percentage share of hydraulic elevators in the market has declined approximately 20-25% worldwide due to the emergence of MRLs, hydraulic elevators are increasingly being installed due to their unbeatable properties such as longer break-down free operation, low initial cost, easy installation, high comfort, etc.

European market is dominated by MRL systems. On the other hand, low-rise elevator market, in developing countries is difficult to deal with. In these markets, traction elevators with machine rooms are leading. Hydraulic elevators are generally unknown there, and constructors suffer from lack of technical personnel. It is expected that MRL and hydraulic shares will reach a constant ratio as the industry becomes familiar with hydraulic elevators.

The first selection criteria for an elevator might be safety. Service-free operation time and the cost of servicing may follow. Hydraulic elevators clearly have the best records in these criteria.

An increase in safe hydraulic elevator installations produced by Turkish companies would help to improve the hydraulic industry in many ways, create new jobs and serve to advance the country in a better way.

The new traction MRL solutions are mostly intended to grasp the low-rise market by creating a monopoly, while overlooking necessary requirements such as safety and reliability. Countries with frequent occurrence of natural disasters should reconsider the acceptance of MRLs straight away. In these cases, the codes should be addressed to sustain a clear understanding of specific safety requirements. Consumer rights is another area to be protected against expensive servicing and component costs.

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