TRIZ APPLICATIONS IN LG CABLE AND CASE STUDIES

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ABSTRACT

First of all, I want to introduce LG Cable briefly. LG Cable produces not only cables but also various products like heat pipe, refrigerator, injection machine, etc. Since 2001, LG Cable has tried to enhance R&D processes and manufacturing processes by applying TRIZ. Therefore, LG Cable opened TRIZ education course and have taught full process of TRIZ to research engineers. And TRIZ has been adapted to practical engineering projects.

Several successful results were achieved through co-work with TRIZ team and research engineers. For instance, the quality of Polymer Insulator and Heat Shrinkable Tube were improved dramatically. The tolerance of Heat Shrinkable Tube was relatively more than 7mm and the production speed was limited by the tolerance. Some solutions which satisfy production speed and quality were developed by TRIZ. And the tensile strength of Polymer Insulator was increased by TRIZ, too.

In this paper, TRIZ applications and activities in LG Cable will be discussed with example of Heat Shrinkable Tube and full processes.

1. INTRODUCTION

LG-Cable, which was one of LG group, was founded in 1962. Originally it was a company which produce and sell cable or wire, but today LG-Cable produce lots of product not only cable, but also tractor, air-conditioning system, small heat pipe, components for Li-ion battery, polymer switch, etc. Business environment of 21 centuries is always changing rapidly, and the company which evolutes fast can only survive in these severe competitions.

What is the key point to survive in the worldwide competitions? In the past, the company which makes the same product at the lower cost can be successful. Nowadays the company which makes new paradigm can hold a dominant position.

To make new paradigm, lots of companies put their money to enhance and to improve R&D process more effectively.

LG-cable noticed that TRIZ can help the research engineers solve engineering problems and generate new concepts. LG-cable noticed that there are some differences between TRIZ and other design or optimization methods. TRIZ is not the methods for quality management or optimization. It is a method for changing existing system to other system. TRIZ is very strong methods for generating new concept and system. Figure 1 is the conventional process to develop solution in the past, and Figure 2 is TRIZ method for guiding right solution of engineering problems.

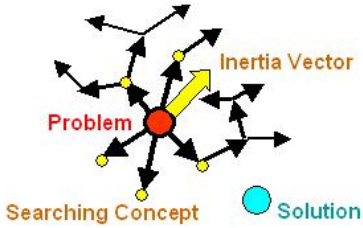

Figure 1. Methods are based on Trial and Error approach

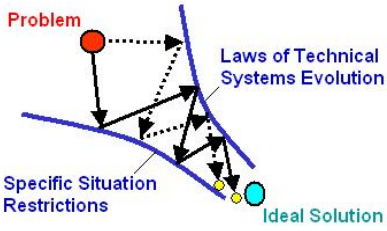

Figure 2. TRIZ directs a problem to Ideal Solution.

2. TRIZ History and Process in LG-Cable

In 2001, LG-Cable introduced TRIZ to the research engineers and in 2002 some of TRIZ experts are invited from LG-electronics to do some projects.

They have done some projects, and in one of the projects the TRIZ experts suggested very good concept which can solve the engineering problem. Before applying TRIZ many engineers tried to solve the problem for long period.

In 2003, LG-cable invited a Russian TRIZ expert, and started to spread TRIZ to the research engineers. Since 2003, 12 research engineers have graduated 96 hours TRIZ course with their project to be a TRIZ solver, and 16 projects were done by using TRIZ. And about 17 patents are made through this co-work with TRIZ team.

In 2005, LG-Cable has a plan to educate introduction and S/W course to 220 research engineers and to set infrastructure for using TRIZ to the projects easily.

In LG-Cable, the TRIZ projects are usually selected by both engineers and project leaders. Some of engineers visit TRIZ team to discuss their engineering problem, If the problem needs kind of computational analysis or optimization (not suitable to TRIZ), TRIZ team pass the problem to computational simulation team.

Anyway, there are usually 4 types of engineering problems.

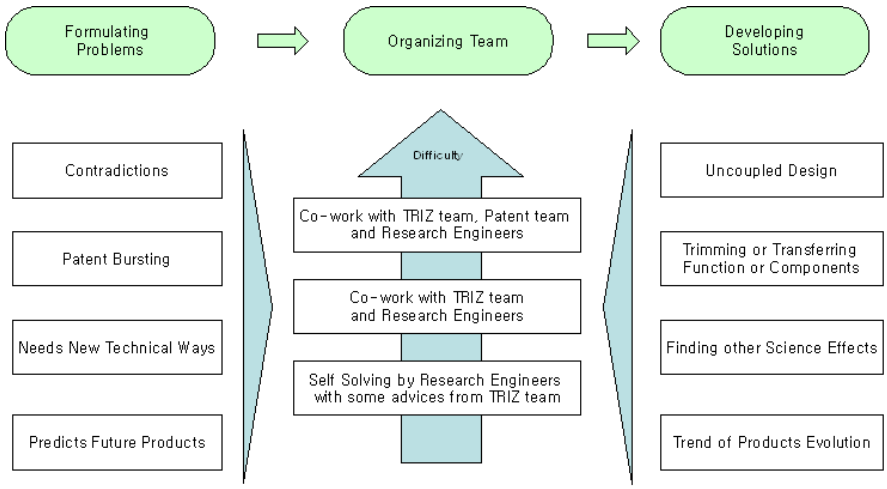

Figure 3.TRIZ process of LG-Cable

In Figure 3, the TRIZ process of LG-Cable is shown. After formulating engineering problem by discussion with research engineer, the level of problem difficulty is set. If the problem needs some of information search, TRIZ team suggested that the research engineer uses TRIZ software and patent analyzing system. In case of the problem which has strong contradiction, TRIZ team and researchers start to co-work for solving problems. In the case of avoiding patents, TRIZ team, researchers, and patent team help each other and share information to develop new methods.

3. Case Study; Introduction of Heat Shrinkable Tube.

Since 2001, some of projects show that it is possible to make successful result by applying TRIZ. The project of improving the quality of Heat Shrinkable Tube was one of the examples.

Heat Shrinkable Tube is a rubber tube which is usually used for insulating wire connection area. Because it memorizes its original diameter, it shrinks in a second when thermal energy is applied as shown Figure 4.

Figure 4. Heat Shrinkable Tube

The process which makes Heat Shrinkable Tube is shown in Figure 5. At first, the original tube is heated over 200’C and is introduced into the expansion pipe which make tube expanded. After Expanding, the tube is cooled rapidly, and some kind of shape memory effects is generated in the tube like figure 6. It is easy to think that there are some springs inside Heat Shrinkable Tube.

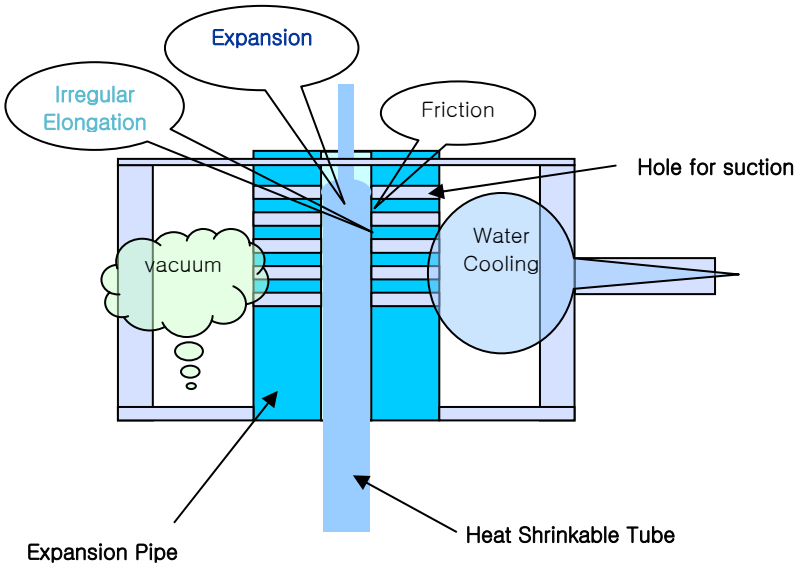

Figure 5. The Process of Expanding Heat Shrinkable Tube

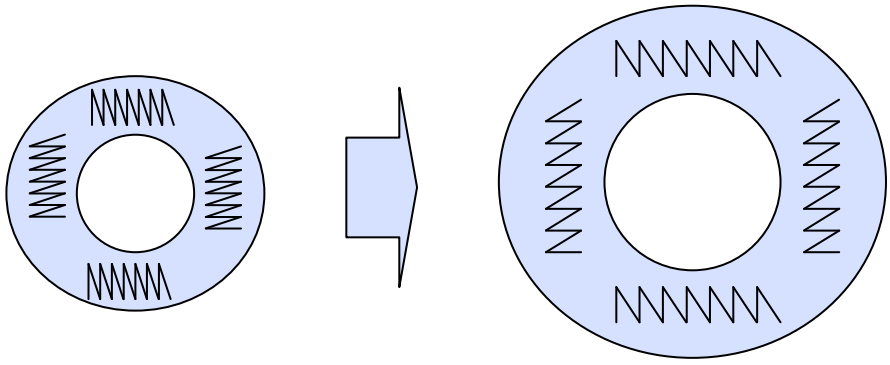

Figure 6. Springs inside of Heat Shrinkable Tube elongated.

At that time, the engineers want to increase the speed of producing Heat Shrinkable Tube. But when the speed of process is increasing, the longitudinal elongations of Heat Shrinkable Tube become more irregular after shrinking. It's because there are shape memory effects inside of Heat Shrinkable Tube not only in the angular direction, but also in the longitudinal direction like figure 7.

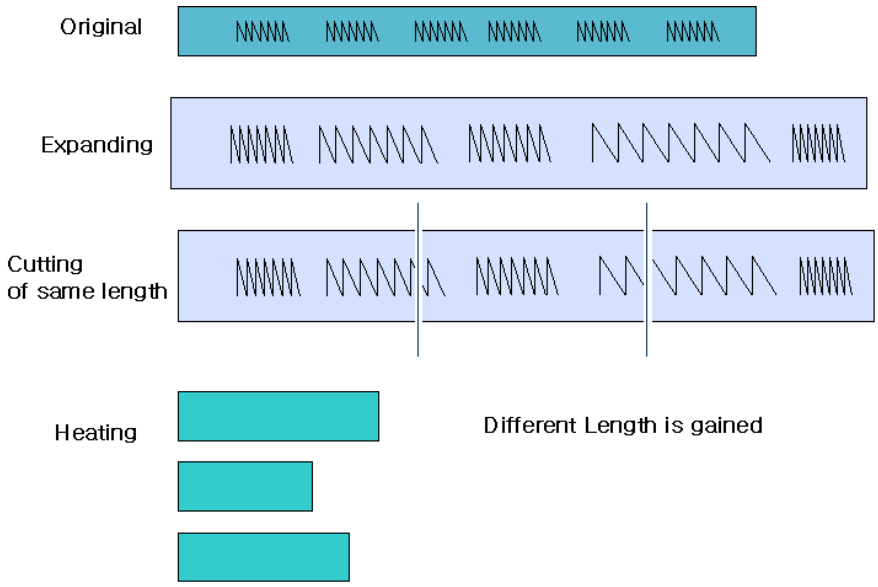

Figure 7.Irregular Longitudinal Extension of Heat Shrinkable Tube

Even though the Heat Shrinkable Tube is cut into the same length, after shrinking the length of each part becomes different because the elongation during expansion process is different.

During rapid expansion inside the expansion pipe, friction is generated between tube and the wall of expansion pipe. Also vacuum is applied inside of expansion pipe. The pressure is not stable. Cooling is also important to decrease time for longitudinal elongations.

Customers of LG-Cable wanted to buy Heat shrinkable Tube which has more regular elongation change. The researchers tried to improve the problem by changing only some of parameters, for example, using colder water, trying to stabilize vacuum pressure, coating inside of expansion pipe to reduce friction, etc. But it was not so effective.

TRIZ team started to co-work to improve the quality of Heat Shrinkable Tube. At first, TRIZ team formulates the initial situation and problem modeling.

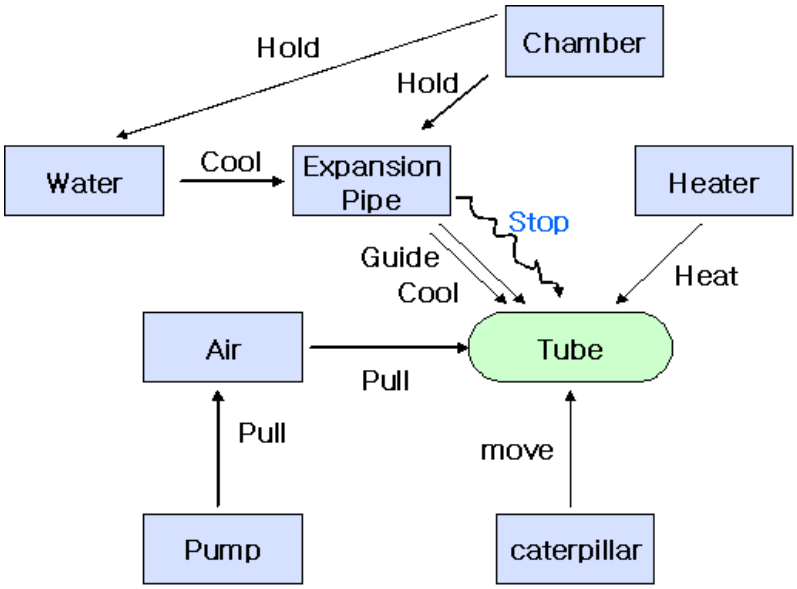

Figure 8.Brief Component Modeling of Expansion Pipe

4. Case Study; Developing New Concepts for Shrinkable Tube

During formulating Problems, many contradictions are derived from analysis. Using this problem modeling, more than 10 concepts were generated to solve the tube's irregular elongation problem.

TRIZ team focused one of the contradictions and it was also a psychological inertia. The contradiction was that the tube should be hot and cold, which is physical contradiction.

If the tube is cold, no elongation is occurred in the Heat Shrinkable tube, but the tube can not be expanded. Engineers thought that the tube must not be cold to make expansion process.

TRIZ team found a similar problem and solution in the other area's examples. It was a pressing and bending process for plate.

In Figure 9, It needs over 1200'C temperature to bend the plate by press, but over 800'C the plate is oxidized. This problem needs high and low temperature at the same time.

To solve the contradiction, the engineers of the press area used surface cooling method. The plate can be bended because the plate is over 1200'C on the whole, and it is not oxidized because the area which meets air is below 800'C.

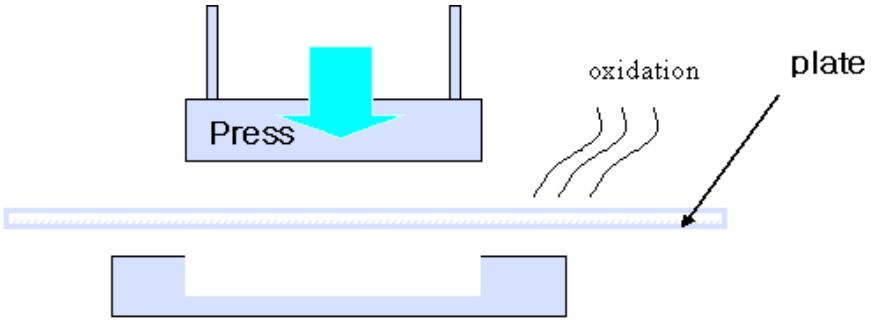

Figure 9.Prevent oxidization during pressing

TRIZ team decided to import the method into expansion pipe system. First of all, the operating time and operating zone were checked. Operating time means the duration time of tube in the expansion pipe.

- operating zone : surface of tube
- operating time : 0.01sec

TRIZ team and research engineers decided that the method of pressing plate without oxidation can be used to reduce the irregular elongation of Heat Shrinkable Tube.

To make similar effect, new design of expansion pipe is suggested in Figure 10.

Like pressing process, if only surface of tube is cooled, the skin is hardened and it can resist the friction between the wall and tube. It makes little elongation of tube during expansion. On the whole, because the tube is hot, the tube can be expanded easily.

To make surface hard, peltier cooler is applied in the upper area of the expansion pipe, because air or metal pipe surface with water cooling was not sufficient for cooling surface of tube.

Robust tube is gained through this method and the longitudinal elongation of Heat Shrinkable Tube is decreased. Before applying TRIZ, the engineer only focused on changing parameters of some components of this system. After applying TRIZ, it is revealed that changing product is also possible way.

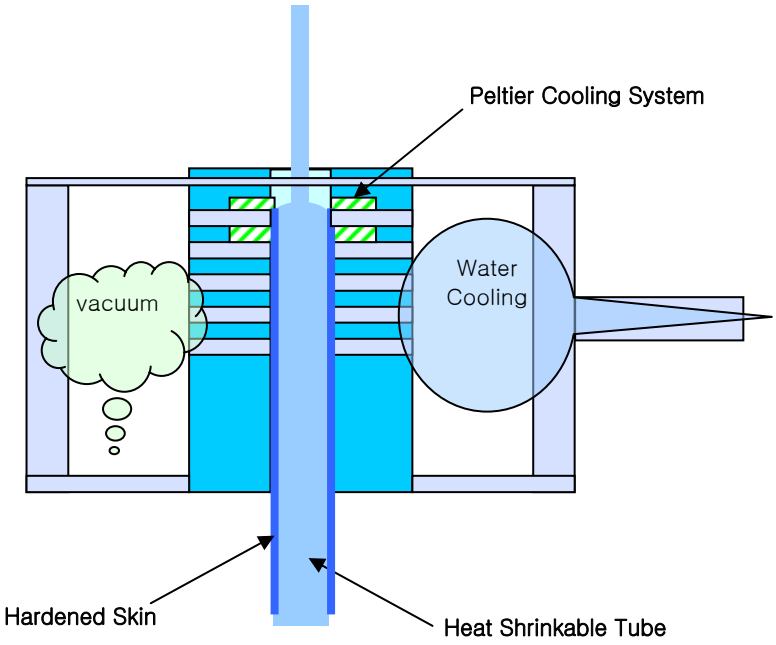

Figure10.Expansion pipe with peltier cooler

The longitudinal tolerance of conventional Heat Shrinkable Tube was 7mm. After using peltier cooler on the top of the expansion pipe, and the tolerance reduced to maximum 5mm per 100mm. The quality of Heat Shrinkable Tube was improved.

5. Conclusion

The case study shown in this paper is one of the examples which are applied in real engineering problem in LG-Cable. Since TRIZ is introduced in LG-Cable in 2001, TRIZ is promoted actively in LG-Cable.

In 2005, LG-Cable will focus on making infrastructure of TRIZ to spread TRIZ more effectively, and will apply TRIZ to various area fields. With co-work with research engineer and patent analysis team, it is expected that synergy effect for improving R&D process will be generated.

6. References

1) Genrich Altshuller, 1997, *40 Principles*, Technical Innovation Center.

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