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TRIZ APPLICATIONS IN LS CABLE AND CASE STUDIES

Kang, Young Ju* ; Kwon, Young Il ; Chung, Pyeong Kwan ;
Alexander Skuratovich

Production Engineering Center, LS Cable
* aeris@lscable.com

ABSTRACT

First of all, I want to introduce LS Cable briefly. LG-Cable changes the name of company to LS-Cable because the ownership of company is changed in 2005. LS Cable produces not only cables but also various products like heat pipe, refrigerator, injection machine, etc. Since 2001, LS Cable has tried to enhance R&D processes and manufacturing processes by applying TRIZ. Therefore, LS 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 10mm 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 LS Cable will be discussed with example of Heat Shrinkable Tube and full processes.

1. INTRODUCTION

LS-Cable, which was one of LS group, was founded in 1962. Originally it was a company which produce and sell cable or wire, but today LS-Cable produce lots of product not only cable, but also tractor, air-conditioning system, small heat pipe in machinery division, and Li-ion battery, polymer switch in component division. Business environment of 21 centuries is always changing rapidly,

and the company which evolves 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.

LS-cable noticed that TRIZ can help the research engineers solve engineering problems and generate new concepts. LS-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.

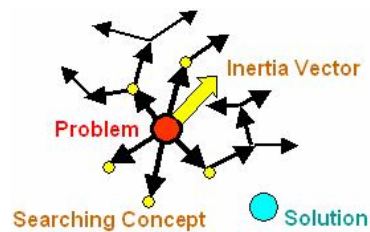


Figure 1. Methods are based on Trial and Error approach

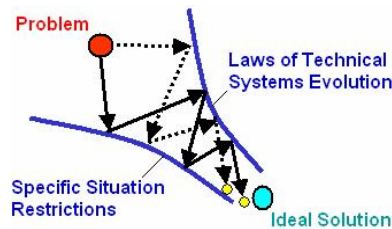


Figure 2. TRIZ directs a problem to Ideal Solution.

2. TRIZ History and Process in LS-Cable

In 2001, LS-Cable introduced TRIZ to the research engineers and in 2002 two TRIZ experts are invited from LG-electronics, and they carried out 3 projects.

During co-work with them, they suggested several good concepts which can solve the engineering problem.

In 2003, LS-cable decided to invite a Russian TRIZ expert to spread TRIZ and adapt 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.

From 2003 to 2004, LS-Cable's TRIZ activities have been focused on supporting individual projects. TRIZ team carried out 13 projects and has made 20 patents. In LS-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.

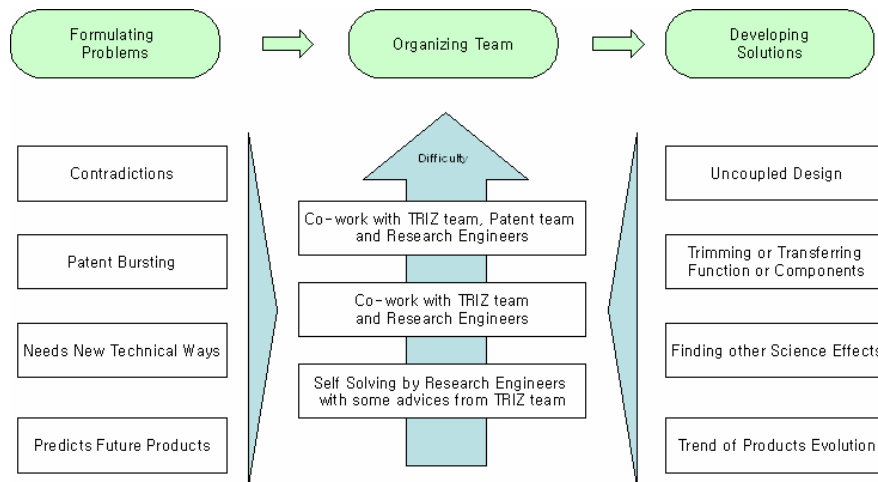


Figure 3. TRIZ process of LS-Cable

In Figure 3, the TRIZ process of LS-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.

But there are several problems only to support engineering projects.

There are saying “Give a man a fish and you feed him for one day. Teach the people to fish and you feed them for all time”

Only giving idea cannot help them to use TRIZ continuously. After finishing co-work, they didn't use TRIZ because TRIZ team only gave them ideas.

In 2005, LS-Cable decided to build infrastructure in the research center to spread TRIZ. And TRIZ S/W introduction course was done to all research engineers.

To spread TRIZ and build infrastructure, LS-TRIZ team noticed that training several TRIZ experts in the company can be effective way to spread TRIZ as shown in Figure 4.

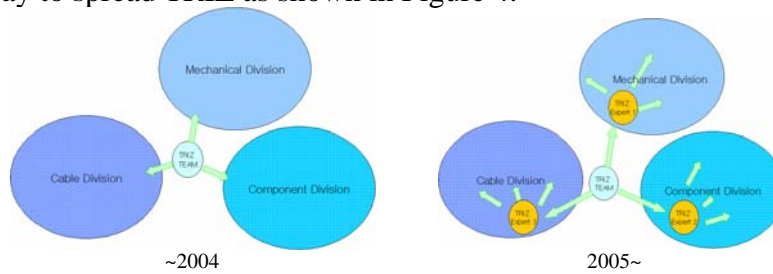


Figure 4.2005 plan for building Infrastructure in LS-Cable

During S/W education, survey about TRIZ was investigated and LS-TRIZ team came to know their needs. After that, TRIZ-team classified every project in the company according to the level and type of engineering problem of each projects. In 2005, LS-Cable will establish infrastructure of TRIZ and support the engineers who want to be TRIZ-experts.

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 is one of the successful 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 5.

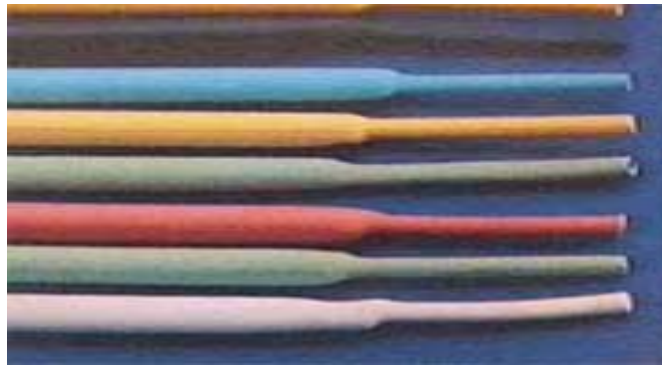


Figure 5. Heat Shrinkable Tube

First of all, we have to analyze engineering system to find technical problem. Usually functional analysis is used for finding problems.

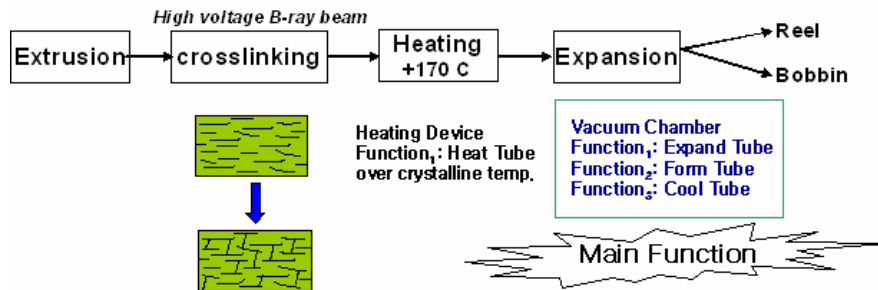


Figure 6. Process of Heat Shrinkable Tube manufacturing

The process which makes Heat Shrinkable Tube is shown in Figure 6. At first, the original tube is heated over 170°C and is introduced into the expansion pipe which make tube expanded. After Expanding, the tube is cooled rapidly because the surface of tube contacts to the wall of expansion pipe as shown in Figure 7. During the process, shape memory effect is generated in the tube

like figure 8. It is easy to think that there are some springs inside Heat Shrinkable Tube.

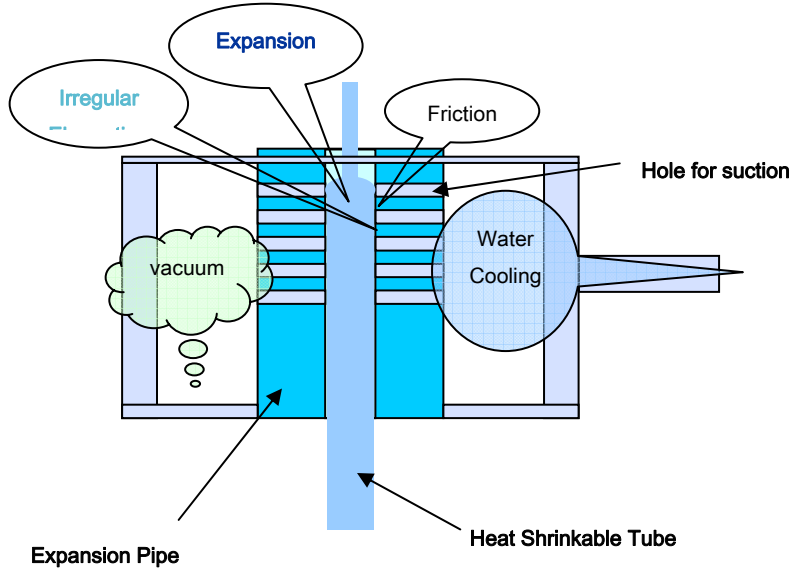


Figure 7. The Process of Expanding Heat Shrinkable Tube

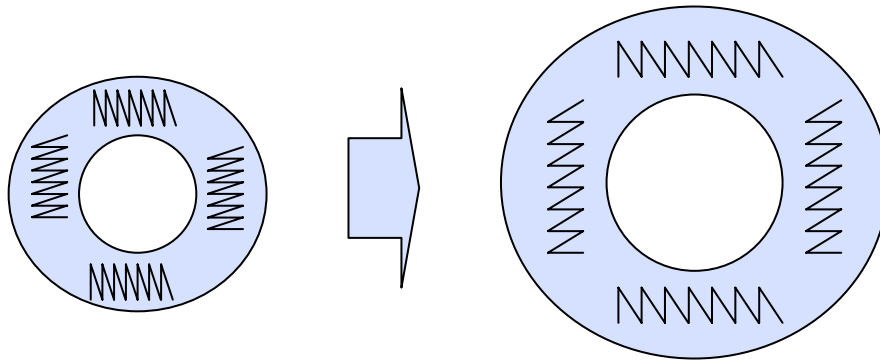


Figure 8. Springs inside of Heat Shrinkable Tube elongated.

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.

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. In this case it can't insulate the electronic component. Figure 9 shows the problem of heat shrinkable tube.

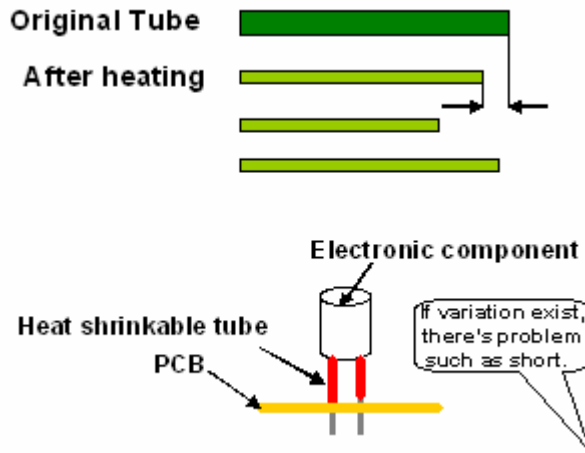


Figure 9. Irregular Longitudinal Extension of Heat Shrinkable Tube

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. Figure 10 shows several estimated reason of problem.

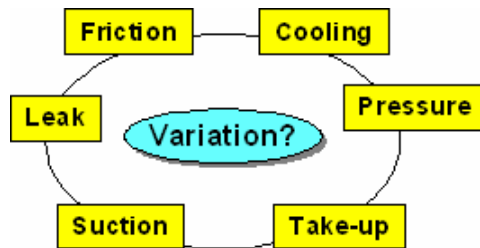


Figure 10. Estimated Source of Problem

Customers of LS-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 to enhance cooling of expansion pipe, trying to stabilize vacuum pressure, Teflon coating inside of

expansion pipe or putting oil to reduce friction (Figure 11). But they were not so effective and generate several undesirable effects.

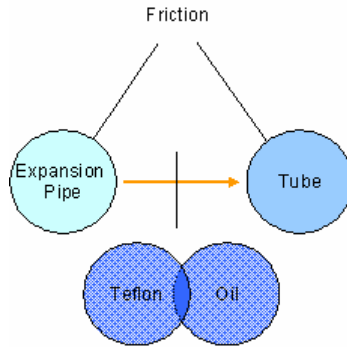


Figure 11. Past Trial to Solve Problem

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 as shown in Figure 12.

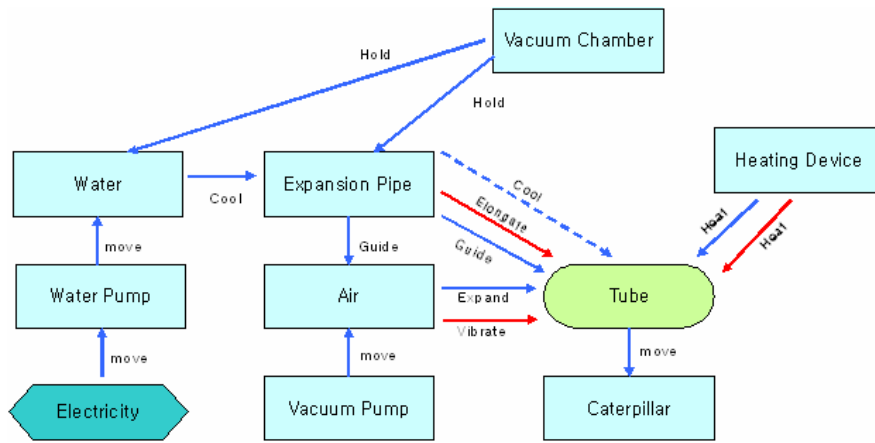


Figure 12. Brief Function Modeling of Expansion Pipe

4. Case Study; Developing New Concepts for Shrinkable Tube

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

At first, TRIZ team found technical contradiction between expansion pipe and Heat Shrinkable Tube. If the speed of production gets faster and faster, the longitudinal elongation became bigger. Figure 13 shows technical contradiction and recommended inventive principles.

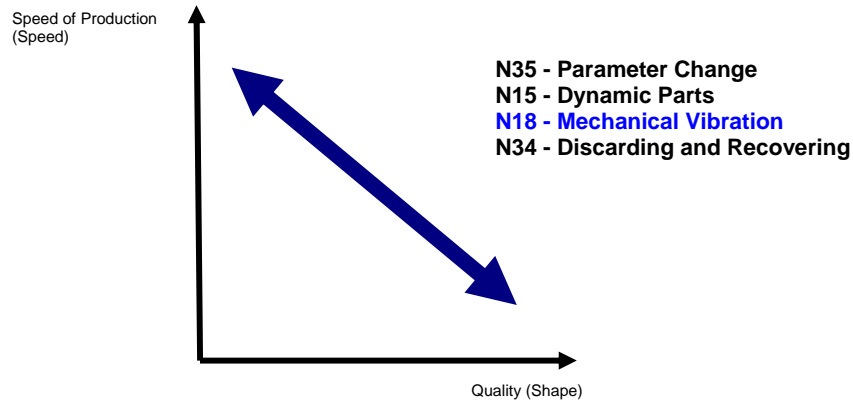


Figure 13. Technical Contradiction of the system

To reduce friction between expansion pipe and Heat Shrinkable Tube, mechanical vibration for reducing friction is suggested, but it needs more cost and device. It increases complexity of technical system, so this method couldn't be used.

TRIZ team focused on 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 14, 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.

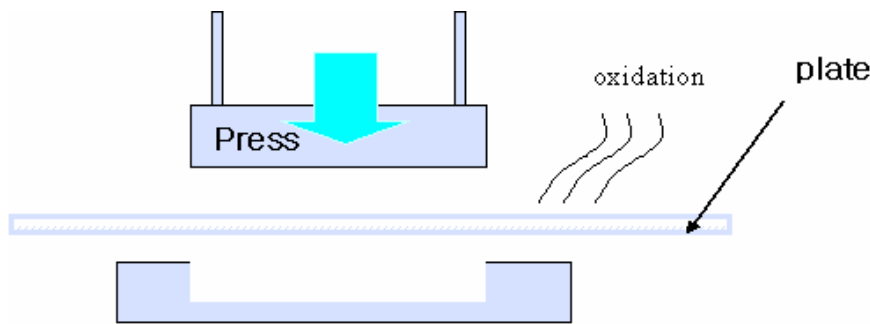


Figure 14. Prevent oxidization during pressing

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 15.

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 as shown in Figure 16. 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. This peltier cooling system is usually used for small cooling system like water purifier.

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. .

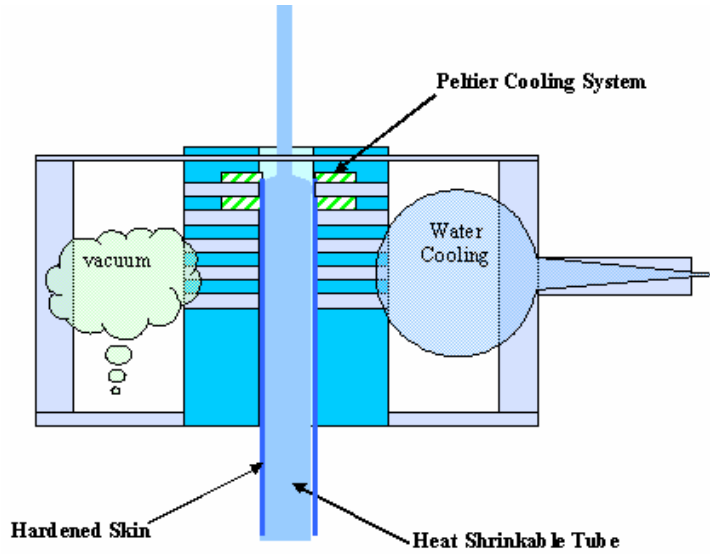


Figure15.Expansion pipe with peltier cooler

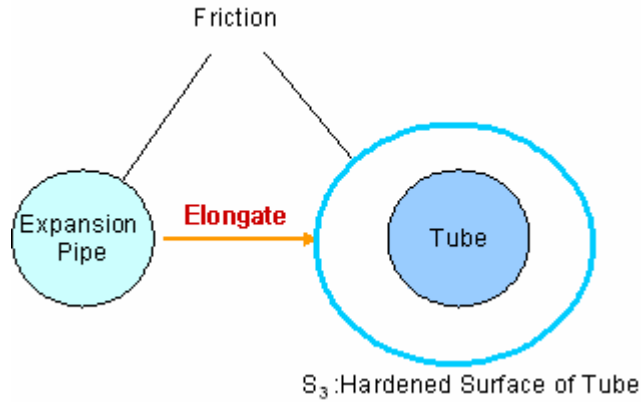


Figure16. Hardened Skin can prevent elongation

The longitudinal tolerance of conventional Heat Shrinkable Tube was 10mm. After using peltier cooler on the top of the expansion pipe, and the tolerance reduced to 5mm per 100mm of length. 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 LS-Cable. Since TRIZ is introduced in LS-Cable in 2001, TRIZ is promoted actively in LS-Cable.

In 2005, LS-Cable will focus on making infrastructure of TRIZ to spread TRIZ more effectively, and will apply TRIZ to various area. 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

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