

Environmental Consciousness in Designing LCD TV AQUOS

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Abstract

The 21st century has started up as a century of the environmental consciousness. In this regard, many aspects of activities for environmental preservation are going on, such as world-wide trends in legislation, changes in either enterprise operations or individual life styles. Consumer appliance makers are also obliged to do the best efforts to develop superior environmentally conscious products. SHARP, the world's top manufacturer of LCD television sets, has already fully committed to this issue through developing products those stand out in the electronic industry. This report introduces the eco-friendly measures adopted in the industry-NO.1 LCD TV "AQUOS".

1. "Green material" technology: which leads to the abolition and/or reduction of harmful chemical substances.
2. Processing and using technology for recycled materials: which contributes to building up a circulation type society.
3. Design technology for recycling, easy to disassemble and/or to separate.

Introduction

As a comprehensive electronics manufacturer, Sharp has made a company-wide commitment to develop people- and Earth-friendly products in order to "contribute to the protection of the natural environment through manufacturing." In particular, LCD TVs have been accepted by consumers as environmentally friendly products because of their thin profile, light weight, energy efficiency and long service life. To further enhance their dominant position as environment-friendly products, Sharp is aggressively working to utilize more environmentally benign "green" materials (using recycled materials and eliminating or reducing the use of toxic substances) in LCD TVs.

Below, we provide an overview of Sharp's proactive measures in this area.

1. Using Green Materials to Develop Environmentally Friendly Products (Eliminate or Reduce the Use of Toxic Substances)

1.1 Halogen-Free Cabinets

Conventional flame-retardant plastics depend on flame retardants based on halogens (elements such as bromine and chlorine) that have the potential to generate dioxins¹ when incinerated. For the plastic in the



Photo 1 The cabinet uses a non-halogen flame retardant

cabinet (outer case) of our AQUOS LCD TVs, however, we adopted a polycarbonate/acrylonitrile-butadiene-styrene (PC/ABS) copolymer employing a halogen-free flame retardant that does not generate dioxins when incinerated.

From the standpoint of safety, we decided to apply 94V-0 standards for fire resistance to the cabinet material and accordingly, chose the PC/ABS alloy, which has inherent fire resistance, augmented with a non-halogen phosphorus-based flame retardant. Compared to halogen-based flame retardants, however, phosphorus-based flame retardants tend to release gas at molding temperatures. Because polycarbonate has a low melt flow rate and poor formability to begin with, their use tends to lead to gas

defects and causes weld lines and sink marks, as well as short shots in the tiny holes of the speaker section, and thus adversely affects the external appearance of the cabinet. This also means that the dies and molding machines must be made somewhat oversize, which increases costs.

For this reason, Sharp began to work in coordination with mold and die makers as well as material manufacturers at the point when 3D design for the cabinet was begun to analyze the resin flow and internal pressures within the mold. By carefully balancing the number and locations of gates, adding vent holes, and positioning mold heaters, we were able to optimize the mold design and size, as well as the size of the molding machine. Also, we standardized on sourcing each individual material from a single supplier, and worked to bring down costs through increasing the quantities we ordered.

Note 1:

- A study originally conducted by the Swiss Federal Institute of Technology in 1982 found that dioxins are released when decabromodiphenyl ether (DBDE), a designated bromine-based flame retardant, is burned at relatively low temperatures of 510° to 630°C, and pointed out the effect of dioxins on human cell cultures.
- Government research organizations and manufacturers of flame retardants in countries around the world subsequently carried out further testing, but whether these combustion gases pose a direct risk to human health remains unclear.
- Environmental laws and regulations covering these materials exist in all countries, and the basic approach of “if there’s any doubt, don’t use them...” means that even halogen-based flame retardants other than these designated bromine-based flame-retardants are not being used.

1.2 Using Chrome-Free Sheet Steel for the Shield and Angle Stock

Previously, we used sheet steel components made of electrogalvanized steel, which had been given a chromating surface treatment, but in Sharp’s LCD TVs, we use chrome-free electrogalvanized sheet steel, which contains no heavy-metal hexavalent chromium² whatsoever. Chrome-free sheet steel cannot be soldered, so we adopted a mechanical chassis construction that eliminates the need for solder. We also reduced the types of materials used, standardized specifications (thickness, etc.), and worked to keep costs down by reducing the parts count and increasing the size of orders to take advantage of economies of scale.

Note 2:

- Hexavalent chromium provides metallic surfaces with excellent corrosion resistance and prevention properties, and is thus widely used as a surface treatment in a large number of industrial products.
- However, hexavalent chromium compounds have long been identified as having adverse effects on human health. They are carcinogenic and highly toxic (oral ingestion can cause a variety of illnesses including gastroenteritis, kidney inflammation, etc.). Skin contact can cause allergic reactions and skin inflammation. Currently there are severe restrictions on the release of hexavalent chromium into the air and into industrial wastewater.
- The environment has also now become a major global issue, and in an effort to protect the environment, regulations controlling the use and disposal of toxic substances have become increasingly strict in recent years, particularly in Europe. In Japan too, efforts in many manufacturing fields to reduce the use of harmful chemicals and prevent their escape into the environment are making progress. In addition to promoting recycling efforts, toxic substances that are difficult to recover to any substantial degree are simply “not being used.”



Photo 2 The shield

1.3 Using Components Free of Polyvinyl Chloride (PVC)

Polyvinyl chloride (PVC) also has the potential to release dioxins when incinerated, and so we substituted polystyrene (PS) for the plastic PVC sheeting covering indicator panels and the like. We are also studying the switch to polyethylene resins from PVC in the sheath of external connecting cables and in interior wire harnesses. We are also working to expand the use of polyethylene in round cables and flexible flat cables (FFC) used for connections inside equipment as necessary. Also, AC power cords and antenna cables tend to deteriorate over time, and so we are conducting studies on how to make immediate improvements in this area.

1.4 Use of Lead-Free Solder on Circuit Boards

All circuit boards (designed by Sharp) used inside AQUOS LCD TV models up to 22 inches in size, and with the exception of certain digital circuit boards, in models 30 inches and larger, use a lead-free solder composed of tin (Sn), silver (Ag) and copper (Cu) containing no lead (Pb)³. Because the melting point of lead-free solder is approximately 30°C higher than conventional lead-based solder, we used components that have exceptional heat resistance and introduced equipment that minimizes temperature fluctuations within the reflow oven. We also adopted new designs intended to combat problem of solder bridges by reducing the diameter of the mounting pads (lands) and new layout patterns for resist printing that prevent bridges from occurring. In the future, Sharp will work to strengthen its efforts to ensure that components procured from China and other countries are also lead-free.

Note 3:

- Lead (Pb) is a prime example of a toxin that accumulates in the bones. When ingested into the body, it can have serious consequences, including causing anemia and central nervous system impairment. Lead is particularly harmful to children, and those with high levels of lead in their blood can develop nervous and mental disabilities.

1.5 Use of Lead-Free Power Cords

For power cords, we adopted green materials that contain no lead stabilizers or DOP (dioctyl phthalate) plasticizers.

We substituted barium and calcium compounds for the lead, but these substances typically tend to cause foaming. To combat this problem, we optimized the mixing percentages and melt temperatures to achieve the same performance and cost as existing products.

2. Contributing to the Creation of a Sustainable Recycling-Oriented Society by Developing Products that Use Recycled Materials

2.1 Recycled Materials Adopted for Use in TV Stand

Originally, stands were injection molded using virgin plastic. However, for the AQUOS LCD TV stands, we adopted a material containing 40% recycled plastic. To accommodate potential reductions in physical properties in the recycled material, such as lower strength, we increased wall thicknesses (6 mm versus the previous 3 mm, for example) and adopted special expanded-foam and blow molding techniques to eliminate any deficiencies in strength.

In the future, we will work together with material manufacturers to develop recycled materials that meet 94V-0 standards for flammability using non-halogen flame retardants. We are also studying the adoption of such materials for components ranging from interior parts such as frames to minor parts such as covers, buttons, etc., and are promoting expanded uses for such materials up to and including outer cabinets.



Photo 3 The stand

2.2 Totally Eliminating the Use of Polystyrene Foam Packaging

We have completely eliminated the use of polystyrene foam packaging materials for all AQUOS LCD TVs models up to 30 inches in size and weighing less than 20 kg. Conventional cushioning makes extensive use of polystyrene foam, which is difficult to recycle or dispose of. To provide better recyclability, we adopted a combination of processed cardboard and a pulp-molded product manufactured from a 50:50 mix of recycled cellulose materials (waste cardboard and recycled newsprint) as the cushioning material for our AQUOS line.

To prevent the cushioning material from changing shape while being dried and to improve its ability to absorb shock, we conducted studies of mold shapes. The results of these tests using dummy molds were then reflected in the development of updated designs for cushioning.

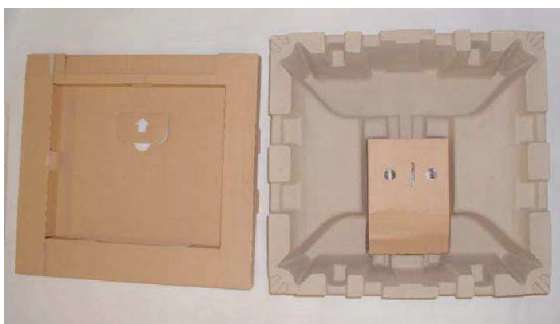


Photo 4 The cushioning material

For AQUOS models with screens over 37 inches in size that weigh over 20 kg, a limited amount of polystyrene foam is used only in sections that require extra strength on top of a base of a cardboard cushioning material. Sharp remains committed to reducing the overall amount of polystyrene foam used in packaging.

3. Developing Products that are Easily Disassembled and Sorted for Recycling

3.1 Use of Standardized Plastics

The cabinets of our AQUOS LCD TVs have been designed with recycling in mind. As mentioned previously, we standardized on using a single type of plastic material consisting of a PC/ABS copolymer. To further facilitate separation and segregation of materials, plastic parts weighing more than 25 g are labeled with information on their primary constituents as well as any flame retardants, additives or fillers they may contain.

In the future, we will also switch to materials that are compatible with the cabinet and will collaborate with material manufacturers to promote development of new cushioning materials, adhesives, and labels that do not need to be stripped off before being recycled as well as adhesives that can be easily peeled off by hand leaving little or no adhesive residue.

3.2 Improvements in Disassembly and Separation

Sharp is working to design products that are readily disassembled and separated into component parts for recycling. These efforts include reducing the number of fasteners, standardizing parts types, ensuring that products can be disassembled using common tools, and eliminating components that contain two or more different materials (for example, plastic and metal).

Efforts under this theme are on-going, and our Production Technology Development Group and the Environmental Protection Group are working together to develop easy-release fasteners based on the use of shape-memory alloys. (Some problems remain to be solved, including fastening strength lower than is desirable, and verifying whether the shape-memory alloy fasteners retain their integrity at high temperatures such as those that would be encountered during containerized transport.)

In addition, concern about recycling is growing as LCD TVs become more popular. An important new theme is improving the recycling rate for LCD TVs in the same manner as CRT-based TVs, one of four types of appliances that currently fall under the Home Appliance Recycling Law in Japan.

Parts and equipment manufacturers as well as other business groups must work together to bring an environmental consciousness to their efforts by taking action to:

1. Establish a system to disassemble, collect and recycle scrap plastic from LCD TVs;
2. Establish technologies to ensure that the physical properties of the cabinet (strength, molded shape, etc.) will last over the product's service life; and,
3. Establish technologies to make it possible to disassemble and separate the polarizer filters, liquid crystal material, spacer resin, glass substrate, and other components that comprise the LCD panel (technologies to enable them to be reused in other types of raw materials have been established).

Conclusions

We have outlined our efforts above to make the AQUOS LCD TV an environmentally friendly product. Many problems remain to be tackled and we do not think that we are making sufficient progress in our actions to resolve these issues.

Still, concern about the environment is increasing around the world, and legislation to protect people and the environment is advancing quickly. Sharp's basic environmental philosophy is that we will apply sincerity and creativity in all our efforts to become a people- and environmentally friendly company. It is our sincere intention to respect all environmental laws and our heartfelt desire to strive daily to develop and promote "green" products that offer outstanding environmental friendliness.

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