Introduction

Reduction of Industrial Waste with Chemical Reactions - Waste from Paint Could be Reduced -

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1 Introduction

Human kinds cannot live without generating waste.

Most companies, particularly manufacturers like KYB, are bound to generate both useful products and industrial waste, namely a negative legacy, at the same time. These two are like be light and shade.

How much energy could we put into coping with the light as well as the shade? We are entering an age where the capability of companies to do so is tested.

KYB Gifu East Plant, which is in a residential area (Photo 1), has taken different environmental measures since its foundation with a goal of building a plant friendly to the local environment.

Photo 1 Gifu East Plant surrounded by a residential area (center)
(Photo created from an official map issued by Geographical Survey Institute)

The use of water-based paint on painted line was one of the measures, and successfully eliminated the odor of organic solvent (so-called thinner) from the plant exhaust and improved the work environment. We thought we could make a good start at that time.

2 Problems of the "Environmentally Friendly" Plant

The painting process generates three types of industrial waste:

① Contaminated paint equipment
Cloth, plastic and paper, such as rags, gloves and masking tape (Photo 2)

② Paint chips
Collected paint deposited on objects other than the product and solidified (Photo 3)

③ Liquid paint waste
Remaining mixed paint after changing color and water used to clean contaminated pipes and nozzles (Photo 4)

Among these, ③ "Liquid paint waste" had not been recognized as industrial waste until the introduction of water-based paint.

Most of the no longer necessary liquid originated in the conventional organic solvent-based paint was purchased and taken out by contractors for solvent recycling or evaporated in the atmosphere. Almost none of the liquid

Photo 2 ① Contaminated painting equipment (actual waste)

Photo 3 ② Paint chips (actual waste)

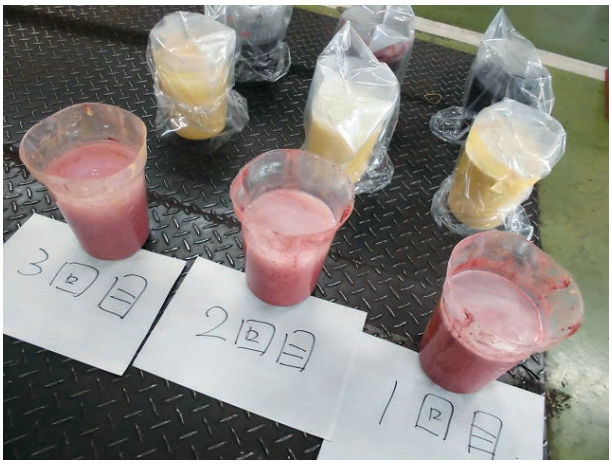


Photo 4 ③ Liquid paint waste (experiment samples)

was disposed of as industrial waste.

However, after introducing the environmentally friendly water-based paint, the plant was caught in a vicious circle:

1) Liquid waste was not purchased by any contractor.

2) Liquid waste was unlikely to evaporate.

3) Extra wash water was needed for cleaning cleaning due to lower cleaning properties.

As a result, a high volume of liquid paint waste was left. In other words, the plant was contradicting itself in that, "the environmental burden was increased by using environmentally friendly paint."

Without having recognized the presence of liquid paint waste, the plant had not given any consideration as to how to treat or dispose of it. The manufacturing team managed to handle the liquid waste by intentionally soaking it in rags out of desperation and disposing of it as contaminated paint equipment, or by mixing it up in paint chips that were originally dry and had almost no moisture.

This way of disposal resulted in drum cans filled with waste that were heavier than usual, leading to higher disposal costs. The extremely wet waste troubled the industrial waste contractors and damping sites.

Gifu East Plant generates a lower volume of industrial waste from the painting process than that from Gifu South Plant, which manufactures similar types of hydraulic machinery products, but the unit weight of industrial waste from Gifu East Plant is obviously higher. This fact was proven by the statistical data (Fig. 1) before I became aware of the issue. This is what I regretted most.

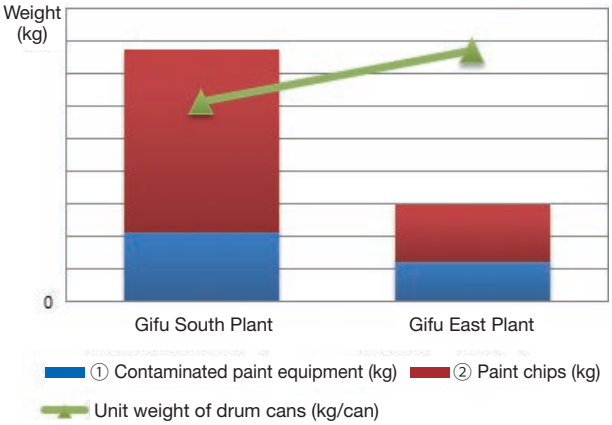


Fig. 1 Waste from paint and unit weights at the two plants (Source: FY2013 data before measures taken)

To begin with, Gifu East Plant conveyed to the employees the procedure of thoroughly separating liquid paint waste (③) without mixing with any other waste on the source manufacturing floor, and then collecting it in a separate "liquid waste" container.

3 Another Problem Triggered by the Measures

Actually I thought "liquid waste", once just separated, could be treated in the sewage treatment facility within the plant site. I did not take things seriously enough. In fact, however, "liquid waste" was not just sewage that could be easily treated.

Numerous troubles happened frequently, for example, liquid spills, container overflow, unremovable paint stains, too slow transfer, and delayed empty containers...

The most troublesome problem was that the pump or hose used to intake liquid waste for treatment was clogged.

I knew that paint was liquid that will solidify sooner or later.

But I never thought paint would solidify anywhere else but in the pump or hose. This was unexpected. Or rather, I was too optimistic.

Of course, paint naturally solidifies when brought into contact with a metallic or resin part of the hose, namely a foreign element. What should we do to prevent paint from solidifying in our favor? Many reasons existed as to why paint could not easily be treated.

What we should treat was not only pure paint, but also liquid waste of different qualities discharged from the painting process that might have been diluted with wash water or mixed with some other contaminants. This liquid waste would solidify at different times or under different conditions (Photo 5).

However, if we wash and rinse paint equipment, including containers, with water, or dilute the liquid every treatment session, it would take a long time to complete

treatment, resulting in inefficient operations and higher costs.

Photo 5 Liquid paint waste whose timing to solidify could not be known

Most of the pump or hose clogging cases were in a muddy semi-solid state. To remove the dirt, acid cleaning with dilute sulfuric acid in addition to water washing was effective. Most of the paint products used were alkaline liquid and the paint itself (except some resin products) never affected the metallic part of the machine.

However, it was unavoidable for the paint to attach to any sliding or rotary parts of the machine because of its own stickiness. Therefore, these movable parts had to be cleaned with acid, which was unfavorable to the metal parts, to restore movement and then have lubricant reapplied. These complicated time-consuming steps were needed every time the machine was clogged.

4 A Sense of Fun Inspires You

One day I came up with an idea that "I'd rather thin the waste with acid than wash with acid every time the machine is clogged" just as a joke!

When I poured dilute sulfuric acid in the liquid paint waste in a bucket, a minor foaming-like change occurred around the liquid surface where the acid was poured. As soon as I stirred the liquid, paint particles in the liquid quickly stuck together to each other. The liquid was split into two layers: mud and liquid. I noticed the liquid had precipitated.

Obviously something changed in the liquid waste with a chemical reaction.

The reaction time of the solid-liquid separation was as short as several minutes. In addition to this reaction time, more time for precipitation was taken. The liquid waste was finally separated into semi-transparent supernatant liquid and precipitate as shown in Photo 6.

This phenomenon is called polymerization [Note 2], in which a bond called condensation [Note 1] continuously takes place. This is one of the macromolecular chemical bonding reactions.

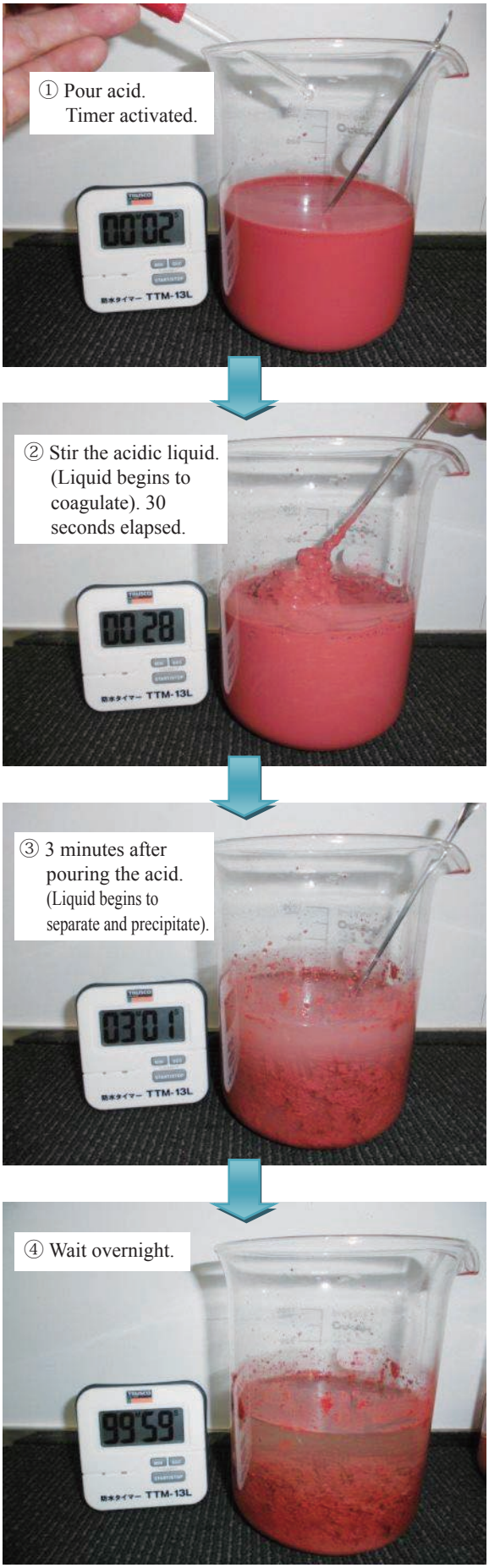


Photo 6 How liquid coagulates with acid

Note 1) A process in which two organic compounds mutually synthesize simple molecules, such as H_2O, from part of their molecules and expel the synthesized molecules so that the two compounds can link with each other (Fig. 2).

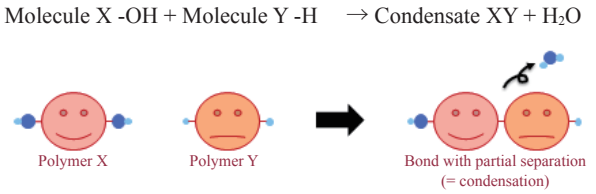
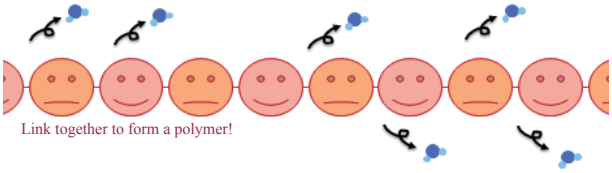


Fig. 2 Sketch of condensation

Note 2) The condensation process is continuously taking place (polymerization) (Fig. 3) to form a chain polymer molecule.



Example) Esterification takes place in a chain reaction to form a polymer called polyester.

Fig. 3 Sketch of polymerization

For oxidation polymerization in drying paint, some molecules are oxidized when exposed to oxygen in the air during the vaporization process of the solvent (actually water in this case) into the atmosphere, causing polymerization. Thus the molecules become dry while chemically bonding together.

The paint's inherent property that is likely to solidify is triggered by forceful oxidation with the addition of dilute sulfuric acid. As a result, the paint is increasingly coagulating itself, even in the water. I discovered this phenomenon by chance.

This finding is not a big discovery or a centurial breakthrough worthy of applying for a patent or being awarded a Nobel Prize. It is just a regular chemical reaction that has been well-known to paint manufacturers for a long time.

Still, the phenomenon of solid-liquid separation I noticed was very effective as an industrial waste countermeasure, which was the original purpose.

Through repeated experiments using a beaker, I finally determined the treatment concept for the liquid paint waste generated from the painted lines at the plant.

1) Liquid paint waste normally generated from the plant including that mixed with washwater, can be treated through solid-liquid separation with almost no problem, although too thick liquid with a high paint concentration solidifies too much and is difficult to treat.
2) The acid used may be dilute sulfuric acid, dilute hydrochloric acid or another acid that can change the pH of the liquid paint waste from neutral to slightly acidic. Although even strongly acidic liquid could be treated, addition of acid should be limited to the extent that it neutralizes the liquid to slightly acidic, to avoid excessive use of chemicals and prevent damage of the equipment.
3) Supernatant liquid can be smoothly treated in the same manner as for other liquid waste without causing clogging in the pump or hose.
4) Liquid paint waste can be reduced to one twentieth in volume or one fiftieth in weight under the best conditions, after being squeezed and sun-cured.
5) Squeezed solid residue can be disposed of as paint waste (industrial waste) (Photo 7).

If this disposal method can be commercialized in the size of buckets or drum cans, the waste volume is expected to be largely reduced, leading to a substantial reduction of the industrial waste from painting operations.

Photo 7 Rag filtering test

5 Waste Disposal Using Waste

Dilute sulfuric acid is always available in the plant where waste water is treated on a regular basis. However, we do not use new chemicals for oxidation of the liquid paint waste. Anyway, the plant is a place in which different kinds of liquid or solid waste are collected. Utilizing such waste would produce much simpler benefits than the discovery of a new chemical reaction.

Waste hydrochloric acid that has expired on the manufacturing floor is regularly collected. If this is reused as the treatment chemical, material cost reduction, or even zero running costs, could be achieved.

In terms of treatment facilities, used baskets and rags are also collected (at no cost or even lower), which are just right to filter the muddy precipitate and squeeze it in order to remove the water content. These waste goods were reused to successfully commercialize the finding at almost no initial cost (Photo 8).

Photo 8 Filtering device I made from waste

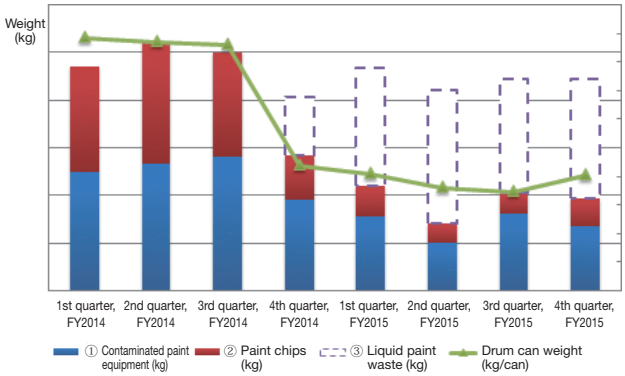


Fig. 4 Output and unit weight of waste from painting operations
(The bar graph enclosed by a dotted line indicates actual reduction and the line graph the unit weight).

This activity achieves all of the 3Rs representing Reduce, Reuse and Recycle, which is one of the environmental consideration keywords. This is a case in which waste reduces waste.

Finally, the following routine disposal procedure has been established on the manufacturing floor partly with the cooperation of the personnel there:

Separation→Fill-up→Container change
↑ ↓

In addition, the internal disposal site established another routine disposal procedure:

Acceptance→Oxidization→Empty containers
↑ ↓

A continual activity cycle has been successfully established through collaboration.

As a result, the initial goal of reducing the unit weight of drum cans containing liquid paint waste by one-half has been achieved, leading to about a 20 ton reduction per year. The new disposal system has taken root (Fig. 4).

Note that the reduction is equivalent to about 15% reduction of the annual output of industrial waste at Gifu East Plant.

6 In Closing

As mentioned in the beginning of this report, products and industrial waste are something like light and shade for the manufacturing industry.

I'm proud of myself that, using cost-conscious ideas and devices, I carried out this activity to reduce the "shade" without reducing the "light", although the core part of the activity began with a chance discovery.

I have to say that the industrial waste contractors we are trading with suffer less business. However, this activity did reduce fuel consumption related to transfer and disposal. I hope we have returned a favor, even slightly, to the global environment.

Finally, I would like to take this opportunity to extend my gratitude to those involved in painting from Manufacturing Sect. who responded to my unreasonable request based on a snap decision with no prospect for outcome, as well as my colleagues who materialized my reckless idea.

Author

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Joined the company in 2011.
Environment & Anti-disaster Control Sect., Production Engineering Dept., Hydraulic Components Operations.
Mainly engaged in building facility maintenance & production utility supply and waste disposal management.