

## Introduction

In recent years, JAPAN domestic manufacturers have moved production bases to foreign countries and reduced investment to existing facilities in Japan. So the domestic facilities are getting old and have a higher risk of unexpected accident or failure. Moreover, the earthquake disaster and environment pollution have increased demands for repair and renewal of facilities. However, due to manpower shortage or increase of un-experienced young personnel, the maintenance and management skills are not handed down from person to person and many companies are worried about repair and renewal of their facilities. We have therefore been working on establishment of nondestructive diagnostic technology and renovation technique for early prediction of an accident risk and creation of an appropriate maintenance measure and plan of thermoplastic pipe equipment. In particular, we introduce a diagnosis and renewal method of tower tank products which often have problems of environment preservation, aging, and corrosion.

## Deterioration Diagnosis of Thermoplastic Tower/Tank products

In general, for the deterioration diagnosis of thermoplastic tanks made of fiber-reinforced plastics (hereinafter referred to as FRP), polyvinyl chloride (PVC), polyethylene (PE), or polypropylene (PP), inside and outside of the tanks are visually checked. The visual check has no clear standard and is dependent on the skill of inspectors, which makes quantitative diagnosis difficult. In addition to the visual check, various types of inspections such as hardness measurement, thickness measurement, peeling strength inspection, or penetrate inspection are combined with each other for a diagnosis suitable to materials and deterioration condition (Fig. 1).

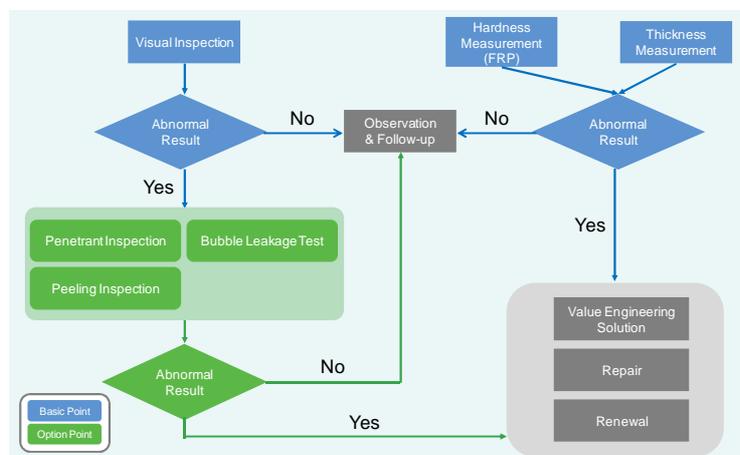


Fig. 1 Sample-flow of Diagnosis of FRP Tank and PVC-FRP Composite Tank

Thermoplastic tanks used outside could be deteriorated by an ultraviolet ray. The deterioration condition of a PVC or PE tank can be diagnosed by shaving the external surface. A thin sample shaved from the tank surface is analyzed with FTIR (Fourier transformation infrared spectrophotometer) to detect a chemical change and evaluate an effect of the ultraviolet ray. This diagnosis is conducted also for PVC pipes. For diagnosing facilities, diagnosis without stopping production lines is most important. We are therefore working on development of a technology to diagnose a tower tank by giving an impact to its external surface. A special hammer is used to give the impact and a reaction force from the resin of the tank surface is analyzed. The diagnosis does not receive a significant influence from a liquid in the tank and is expected to be highly efficient.

## Renewal of Tower/Tank products (Panel Construction: Dividing Method)



Photo 1 Panel-type Tank

For the renewal of a tower tank product, a product made in an integrated form is delivered and installed. However, the delivery is sometimes difficult depending on the installation place. In this case, it is necessary to make opening on roof or wall of a building, which increases cost and construction period. We then realized renewal of facilities that could not have been renewed, using the panel construction method which took advantage of the property of PP (Photos 1 and 2).

In this panel construction, product components manufactured separately are assembled and joined to each other on the site. Use of the separated components solves the problem of carrying the product in the site or the problem of too large product to convey on road. Therefore this method can save on-site construction work and reduce the transportation cost. Moreover, the components can be made further smaller to carry in through a manhole of the diameter of about  $\phi 600$ . We can take a flexible measure depending on the installation place and the condition of travelling route.



Photo 2 Divided-type Tank

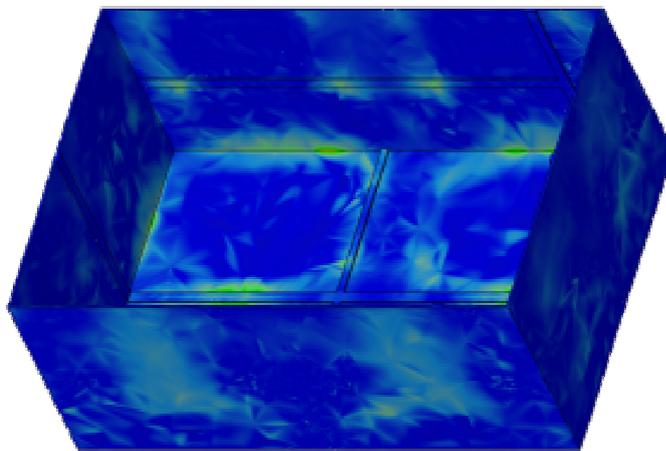
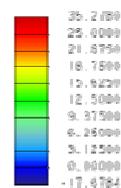


Fig. 2 Stress Analysis with 3D-Model



### Characteristics of Panel Construction

- The products are manufactured in the most suitable form to installation site.
- Extrusion welding after on-site assembling ensures sufficient strength of integrated tank.
- Gasket-less structure allows long-term use of the tank for chemical liquid.
- A countermeasure against odor is not necessary since a solvent is not used in the construction.
- Unlike FRP, it does not require curing (drying) process.

## Pit renewal by Loose Lining

The Water Pollution Prevention Act in JAPAN was amended in 2012. In the amendment, owners of facilities where toxic substances are used or stored are obliged to follow the standards on the structure, equipment, and use of the facilities for prevention of underground leakage, perform regular inspection, and record and save record of the inspection.



Companies therefore need to strengthen their preventive measures against leakage from waste acid pits in factories. For the leakage prevention, corrosion-resistant lining is usually performed with FRP, appropriate painting method, or sheet adhesion method. However, this method requires a repair/drying process for the base material and a curing (drying) stage after the completion of the construction, and hence the period during which the facilities are stopped is often long. To solve these problems, we have developed a loose lining method which uses hard thermoplastic sheets (Photo 3).

Photo 3 PP Sheet Lining

The loose lining is a method to fix a hard thermoplastic sheet on a framework using anchor without adhesive agent. Therefore, it does not require complete drying of base material and the construction work can be started soon after liquid extracting work. Also since sheets used for lining are welding-joined, curing period to wait for hardening and drying is not necessary unlike in the adhesion method or wet method for FRP lining. So the customer can start using the facilities immediately after the completion of the construction. Figure 3 shows comparison of the construction period between different construction methods.

Process	Period	
	FRP	PP
1. Dry out before Rebuilding	1 day	Unnecessary
2. Surface Treatment/Preparation/Putty	2 days	1 day
3. Primer coating/Drying	2 days	Unnecessary
4. Lining - Body & Nozzle -	5 days	4 days
5. Finish - Topcoat -	1 day	Unnecessary
6. Dry curing	2 days	Unnecessary
<b>Total</b>	<b>13 days</b>	<b>5 days</b>

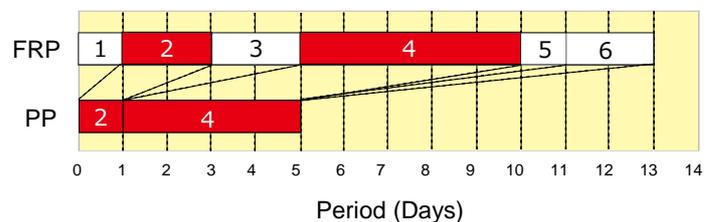


Fig. 3 Comparison of Construction Period between Different Methods with FRP and PP



Photo 4 Spark Test

Filling water test is commonly used to check the post-construction condition. However, it takes long time and cannot detect small amount of water leakage. The insulation property of the resin is used to perform a spark test (Photo 4) and check the sealing property of sheet joints during construction.

We are also working on not only pit but also internal renewal of existing tanks using hard thermoplastic sheets. Usually, 3-5 mm thick sheets are used for lining. However if a steel material directly contacts the lining surface as in plating facilities, a defect could be caused on the surface. In this case, we propose using 30-40 mm thick sheets to ensure sufficiently high corrosion resistance even in the presence of a defect on the surface. In addition, parts that are manufactured in advance in a suitable form to the existing tank are carried in (Photo 5) to shorten the on-site construction period. Like panel-constructed tower/tank products, the parts are simply assembled and joined on the site, which can shorten the construction period considerably.



Photo 5 Internal Renewal of Existing Tank  
(L: 15200mm x W: 2200mm x H: 2200mm)

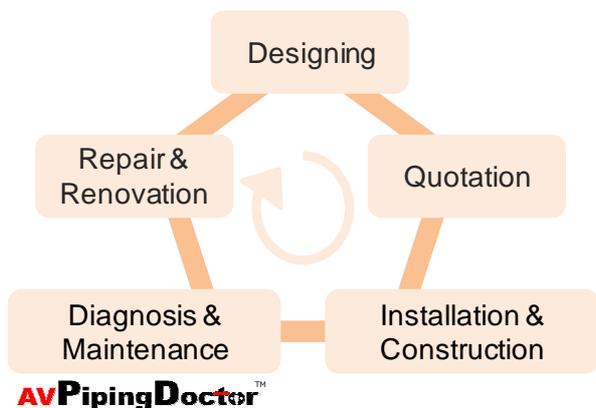


Fig. 4 Support Cycle

## Conclusion

So far, rubber lining and FRP tanks have been often used as materials of highly corrosion/heat resistance. In recent years, however, alternative products have been demanded to compensate labor shortage and reduce running cost.

PP products are used as highly corrosion/heat resistant materials in Europe and USA. In Japan, they have been used since 5 years ago in the steel industry and chemical industry.

Our company provides not only pipes and valves but also PP tower tanks and secondary processed products, aiming to become a leading company in the niche field of chemical resistance. Also, through the deterioration diagnosis and customer services, we share problems and troubles of customer's pipe systems to provide multiplex support including proposal, material supply, and construction (Fig. 4).