【Technical Report】

Longer Piping Life Cycle of New Generation Large Valve

New Development of ASAHIAV Butterfly Valve Type58

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Valve & Piping Systems Administration

Introduction

ASAHI YUKIZAI CORPORATION has been engaged in the manufacturing and sales of thermoplastic valves for more than 60 years. Thermoplastic valves called Butterfly Valves were first developed in 1969, and after that the history of Large Size Butterfly Valves started in 1986. After the world's first FRP-made Large Size Butterfly Valve with a diameter of 1200 mm was developed, Large Size Butterfly Valves became our company's symbolic product. They were used for water service in the agricultural industry and at chemical plants both at home and abroad, and they helped achieve a lot of accomplishments. In early 2000 a second generation of them was developed as RIM (reaction injection molding) products, overcoming the challenges of FRP manufacturing. In July 2016, the next generation Large Size Butterfly Valve Type 58 was born, which satisfied the demand for high strength and corrosion resistance.

The Next generation Large Size Butterfly Valve (Type 58)

Features of the Butterfly Valve Type 58

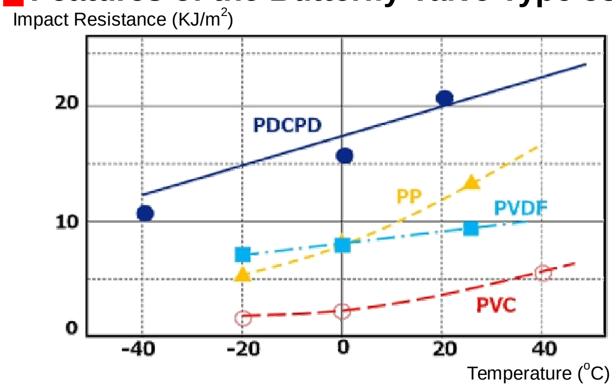

Fig.-1 The impact strength of various materials is shown in accordance with their temperature

This is the reason why Large Size Butterfly Valves have been widely used in cold areas, including Hokkaido and Tohoku in north JAPAN. In addition, PDCPD has high resistance against gravity, which greatly contributes to the weight reduction of the valve body.

Polypropylene (hereafter PP) and polyvinylidene-floride (hereafter PVDF) can be used as materials for the valve body, depending on its application. PP has excellent alkali resistance, so it is versatile for general use. In contrast, PVDF has excellent acid resistance, and due to the high strength in its fluorine resins, it is often used in special applications. (Fig.-2)

Fig.-2 Corrosion resistance of the materials used in the valve

	Acid	Alkali
Polydicyclo pentadien (PDCPD)	Not Good	Good
Polypropylene (PP)	Good	Excellent
Polyvinylidene floride (PVDF)	Excellent	Not Good
Stainless Steel (Sus304)	Not Recommended	Excellent

Made from High Corrosion-resistant Materials

Our thermoplastics have a long standing history of superior performance and this was used in the Butterfly Valve Type 58 (Table-1)

Polydicyclo pentadien (hereafter PDCPD) thermoplastic is used in the valve box. The features of this material are as follows: RIM molds are used for its large-sized molded articles, which have more variety and are low in volume, because they can be made easily, and it has excellent impact resistance at low temperatures (Fig.-1)

Table-1 Comparison of the proprieties of the materials used in the thermoplastic valves

Items	PDCPD	PVC	PP	PVDF
Specific Gravity	1.04	1.43	0.92	1.76
Tensile Strength (MPa)	44~54	49~54	29~34	55~60
Longitudinal Modulus(MPa)	1980	3200	1030	1700
Izod Impact Strength(KJ/m^2)	20	4~5	13	8~10
Heat Distortion Temperature(°C)	20	74	110	150
Poisson's ratio	0.41	0.37	0.44	0.28

Data at Normal Temp.

PP and PVDF valve bodies are the standard materials used in thermoplastic valves and are used in a number of piping materials, including chlorine gas and coating solution lines in soda electrolysis plants, acid and nitric acid lines in ironworks, hypochlorous soda lines for sterilization, and etching solution lines for liquid crystal. This thermoplastic is molded using large injection molding machines at our own factory, which has Japan's leading mold clamping force of 5,000tons. (Photo 2)

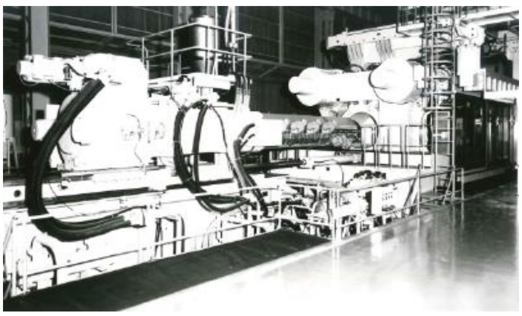

Photo 2 The large injection molding machine with a force of 5,000 tons

Molding technology based on a hybrid structure design

While establishing a position as a thermoplastic valve manufacturer, our company also developed insert molding technology where metal parts are embedded in the thermoplastic to reinforce the valves.

In general, there are not many valves with a large diameter in which metals are inserted into and molded. The reason for this is that it is difficult to mold metals because they are heavier than thermoplastic and molding is likely to fail because flow-ability is hindered due to the metal parts inserted at the time of molding. In addition, the production of large molded articles requires enormous costs for capital investment for molding and forming, so continually reproducing the actual products using prototypes is practically impossible. Therefore, for the development of this product, an accurate simulation technique is required.

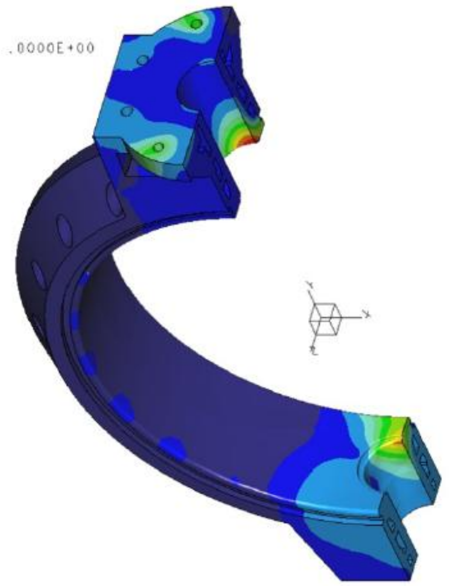

Fig.-2 FEM analysis of the valve body

We showed examples of the FEM analysis using CAE, assuming that pressure is applied to the valve. By making full use of this FEM analysis, it became possible to minimize the weight of the metal reinforcing components used for the valve box or the valve body. Thus, we were able to reduce the weight of the product by up to around 50% compared to the conventional product. Due to this weight reduction, we can expect a reduction in its comprehensive costs, including the costs for transportation, installation and maintenance work with the valves.

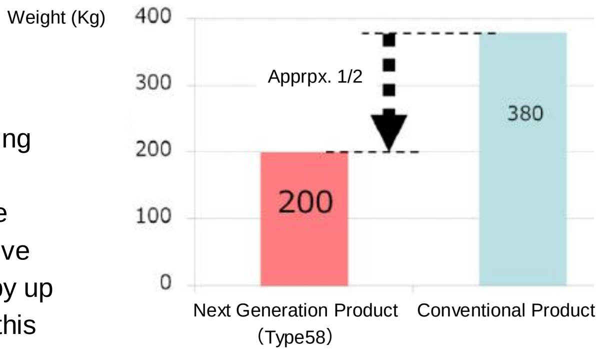

Fig.-3 The difference in weight between the next generation product and the conventional product

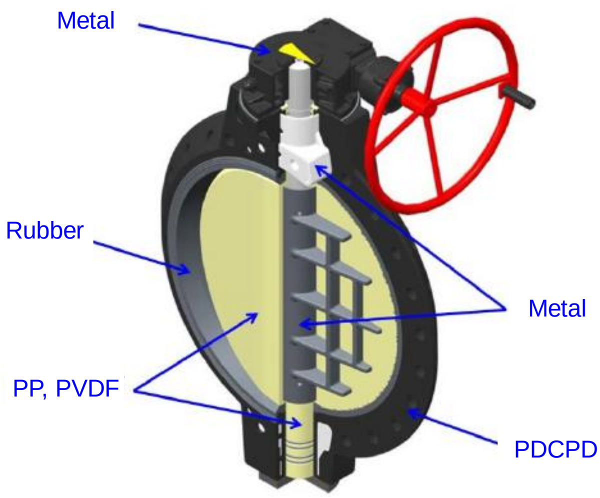

Fig.-4 Hybrid structure design with thermoplastic and metal

By integrating our own large-scale metal insert molding technology with highly accurate simulation technology, we were able to develop large diameter Butterfly Valve Type 58, which is "light", "high-strength" and has "high corrosion resistance" due to the hybrid structure of metal and thermoplastic (Fig.-4). In addition, owing to our adequate simulation experiences, we were able to minimize problems with trial and error. Thus our products passed harsh assessment tests in a short period of time, including a short-term pressure (valve seat seal) test, an open and close test, and a hot water flow test.(Table-3)

Table-3 Performance evaluation items and the results

Evaluation Item	Test Description	Result
Short-term Pressure Test	No leakage required to the Valve seal pressurized up to 0.9MPa (0.75MPa x 1.2)	Passed
Hot Water Flow Test	No leakage required to the Valve seal pressurized up to 0.6MPa (0.5MPa x 1.2) after the liquid flowed 720 Hours at 80°C temperature.	Passed
Open & Close Test	No leakage required to the Valve seal pressurized up to 0.9MPa (0.75MPa x 1.2) after the valve cycled 10,000 times to open and closed	Passed

Technical specifications

The pipe connections correspond to flange standards, including JIS10k, ANSI 150Lb and DIN PN10; the valve surface corresponds to the ISO5752 short and wafer types which don't require a flange gasket; the top flange complies with ISO5211; and the connection portion with the mounted drive unit has compatibility. In order to maintain the equivalent valve seat seal performance (0.75MPa) and the opening and closing durability of conventional products, we went with a central type structure.

Expectations for the Longer Piping Life Cycle

In recent years, as a comprehensive strategy to reduce costs for piping materials in power plant facilities, long service life that requires less maintenance is strongly desired. In particular, the market for thermoplastic valves with corrosion resistance is growing for things such as water intake lines for cooling turbines and sulfuric acid circulation lines for flue gas desulfurization.

Overseas, as an alternative to expensive acid resistant metal valves in copper mines in South America, Butterfly Valve Type 58 has been installed (Photo 3). We found that valves needed to be replaced every two years due to external leakage in the metal of valves at a seawater desalination facility in the Middle East (Photo 4), so we publicized that our thermoplastic valves would help to prolong the service lives of their facilities, and then they decided to replace to our Butterfly Valve Type 58.

Photo 3 Butterfly Valves have been employed in mines in South America

Photo 4 A seawater desalination facility in the Middle East

Future Deployment

For future sales expansion of our Large Size Thermoplastic Butterfly Valves (larger than 700mm), we are planning the reinforcement of our manufacturing facilities to realize stable production levels and reduce delivery times of our products.
We have embarked on the development of 800mm and 900mm sized valves from this year, and moreover, we are also considering producing valves that are larger than1000mm. (Photo 5, Photo 6)

Photo 5 Using metal valves caused external leakage

Photo 6 they were replaced with Butterfly Valve Type 58

Conclusion

Our Company is focusing on "usability as piping material", i.e. "corrosion resistance" and "weight reduction", which cannot be realized in standard metal valves. Furthermore, our aim is to build on the techniques of successful thermoplastic valves created by our predecessors. Thus, we hope to contribute to the development of the industry.