

## An impact on screw cylinder during molding LIMEX

LIMEX is defined as "LIMEX is a composite material of inorganic filler dispersion that contain over 50% of inorganic substances such as  $\text{CaCO}_3$ " Thus, inorganic substances are contained in MB, and some molding manufacturer has a consideration of abrasion to screw cylinder. This material shows our opinion regarding this concern.

- about an impact to screw.
- Basally, it is said that screw duration lifetime is supposed to be for 5 to 10 years. However, the lifetime is going to be changed depending on resin type and recycle time and other factors that may damage the screw.
- Generally, it is though that corrosion caused of produced gas during resin heating has bigger impact level than the factor of screw and cylinder deterioration due to abrasion caused by compressive shear.
- In the case of relative evaluation, if carbon containing material is 10,  $\text{CaCO}_3$  is 2~3. Talc has more tender mosh hardness than  $\text{CaCO}_3$ , but talc particles are angular and  $\text{CaCO}_3$  is round in shape so talc tends to have a bigger impact.

	Carbon containing material	Glass containing material	Talc containing material	$\text{CaCO}_3$ containing material
Impact against screw	10	5	3~4	2~3

- General screw grade can be classified as follow.

grade	SCM plating	nitride	Nitride plating	KPS	A	B	C
type	Chromium molybdenum steel	Steel nitride	Steel nitride +plating	KPS6	YPT4 +plating	YPT71 +plating	YPT71 +plating
Trait	general	general	Resin adhesion reduction	Standard corrosion and abrasion resistance	Standard corrosion and abrasion resistance	High corrosion and abrasion resistance	Ultra corrosion resistant abrasion
Purpose	normal	normal	Dislike food contamination	Severe usage conditions	Such as high recycle, Severe usage conditions	Glass filler containing resin	Glass filler high containing resin

Abrasion resistance

High

LIMEX does not need the screw of "High grade Anti-corrosion and abrasion" Screw coating is used for preventing the foreign material for food, but it is not for increasing the strength of abrasion.

- The Mohs hardness of limestone (calcite) is as follows

Mohs Hardness	Material	Chemical Formula	Note
1	Talc	$\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$	Softest mineral. Smooth touch. Easy to scratch by nail.
2	Gypsum	$\text{CaSO}_4 \cdot \text{H}_2\text{O}$	Can be scratched by nail
3	Calcite	$\text{CaCO}_3$	Can be scratched by coin
4	Fluoric	$\text{CaF}_2$	Easy to scratch by knife
5	Apatite	$\text{Ca}_5(\text{PO}_4)_3(\text{F},\text{OH})$	Can be scratched by knife
6	Orthoclase	$\text{KAlSi}_3\text{O}_8$	Can be scratched by knife but knife will hurt
7	Quartz	$\text{SiO}_2$	Can make a scratch to glass and steel
8	Topaz	$\text{Al}_2\text{SiO}_4(\text{F},\text{OH})$	Can make a scratch to quartz
9	Corundum	$\text{Al}_2\text{O}_3$	Can make a scratch to quartz and topaz
10	Diamond	C	Hardest material in earth. Can make a scratch to corundum

- We have been using LIMEX for extrusion molding at our factory, and we have not received any reports of damages in the last five years.
- We have also interviewed the manufacturers of injection molding machines and extruders, and have not found any cases of damages caused by  $\text{CaCO}_3$  masterbatches.
- How to reduce the impact on heating cylinders and screws as much as possible in molding conditions?
- It is possible to reduce it by eliminating the load of the filled resin in the cylinder as much as possible.
- Decreasing screw speed can reduce the impact(Injection and Blow molding case).But please do not extend the cooling time in the case of injection molding.
- Raising the heater temperature at the resin input port under the hopper can reduce the impact. (Injection, Extrusion, Blow and Blown film molding case)
- Reducing the back pressure in the cylinder can decrease the density in it and this can reduce the impact.(Injection molding case)
- If you want to reduce injection shot variability as much as possible, it is possible to extend the lifetime of the screw by periodically changing the amount of cushion and avoiding using only the same part of the screw.(Injection molding case)

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With the cooperation of Sumitomo Heavy Industries, Ltd., TBM asked them to feed LIMEX pellets into their own machine and checked the effect on the screw/cylinder/three-point set(screw head, check ring, seal ring). We also evaluated titanium dioxide containing to increase whiteness simultaneously for comparison.

Test condition

•Each grade was purged with 10,000 shots for two LIMEX pellet grades, and the dimensions of the parts were measured to evaluate the amount of abrasion.

< LIMEX pellet grade>

PP60-02HUC(standard grade)/PP60-T0004(titanium dioxide containing grade) ※ Drying at 90℃ for 2 hours

•Equipment:

C250 plasticizing test stand

φ28 screw ASSY needle nozzle

MATSUI dryer MJ5-i-150-J

• Evaluation parts : Applying the screw ASSY of

SHI standard specification

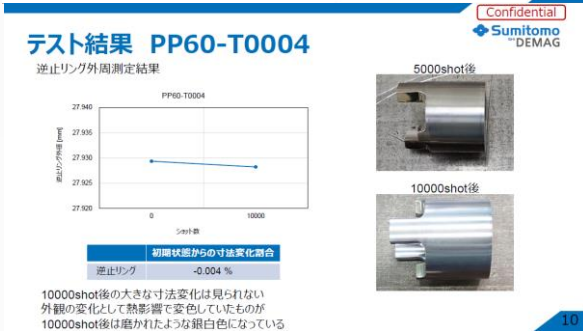
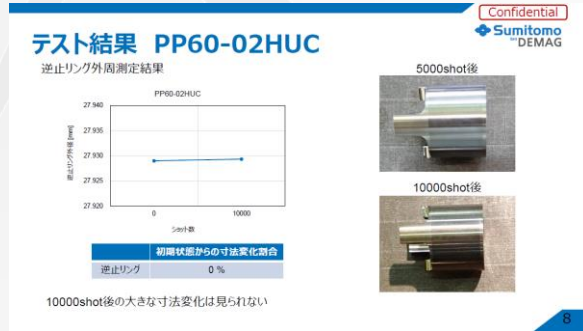
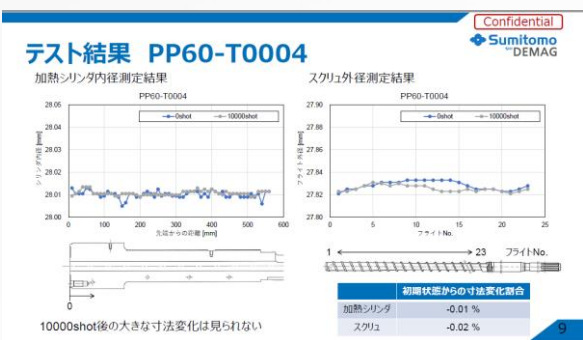
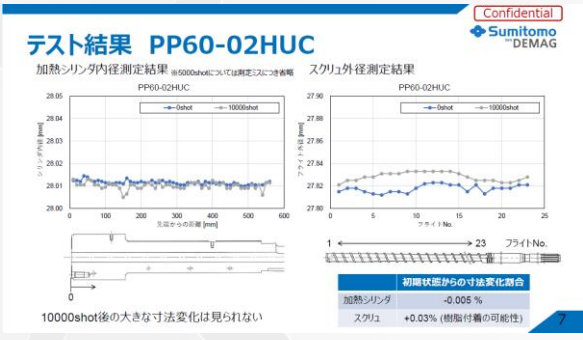
(nitriding specification), which is the main specification in the container segment where this resin is expected to be used.

Parts name	material	Vickers hardness Hv	Measuring point
Heating cylinder	Steel nitride	Over 700	Inner diameter
screw	nitride steel	655~695	Flight outer diameter
Screw head	Steel tool	Over 700	
Check ring	Steel tool	575~625	Outer diameter
seal ring	Steel tool	500~560	

※Limestone Vickers HardnessHv115

PP60-T0004(Titanium dioxide content grade)

PP60-02HUC(standard grade)



Conclusion

- Regarding 2 grade of LIMEX pellets, the abrasion condition of screw ASSY parts was evaluated by pursuing for 10000 shots.
- After the test, no abrasion was appeared on any of the measured parts for either LIMEX pellets.
- Although no dimensional change occurred after purging PP60-T0004 for 10000 shots, there is a possibility that further shots may cause wear accompanied by dimensional change, but at 10,000 shots, it is not expected to affect molding.

※ As a rough guide to the "percentage of dimensional change from the initial state" in Sumitomo Heavy Industries' report, 0.005%/5% is considered to be the degree of influence of this time.

If you have any questions on it, please contact the TBM development department.  
Mail: [TBM Corporation contact@tb-m.com](mailto:TBM Corporation contact@tb-m.com)