The water absorption and conditioning of molded parts in Durethan®

Lanxess HK

Semi-Crystalline Product

Asia Pacific

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Topics

1. Water Absorption Behavior of Polyamide
2. Effect of Water Absorption on Molded Parts
3. Factors Affecting Water Absorption
4. Conditioning

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Water Absorption Behavior

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Water Absorption Behavior

- Characteristic of semi-crystalline polyamide
- Different type of polyamide
  - → *Different extent of water absorption*
  - → *Depends on CH_2 to CONH group Ratio*
- Practically, 2 values specified
  - → *Saturation state after immersion in water*
  - → *Standard atmosphere (DIN 50014, 23^{o}C, 50% RH)*

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Water Absorption Behavior

- A reversible process
- Water is bonded into polyamide by
  - → *Hydrogen bridges*
- Weakens the intermolecular forces
  - → *Plasticising effect*
  - → *Reduce glass translation temp.*
  - → *Increase volume / dimension*

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Water Absorption Behavior

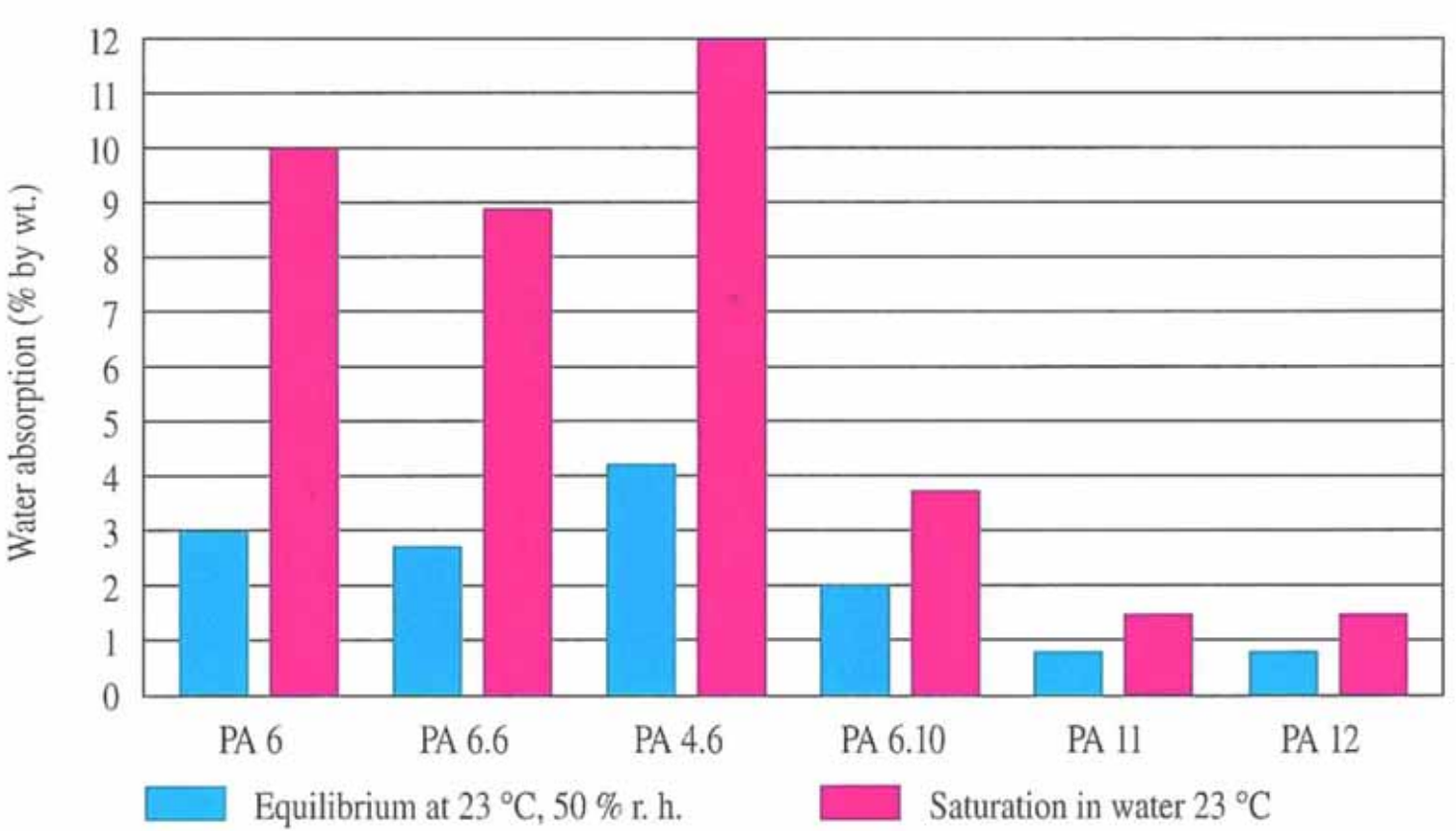

Figure 1: Water absorption of polyamide moldings when saturated following immersion in water at 23oC and their state of equilibrium in a standard atmosphere of 23 °C, 50% of relative humidity.

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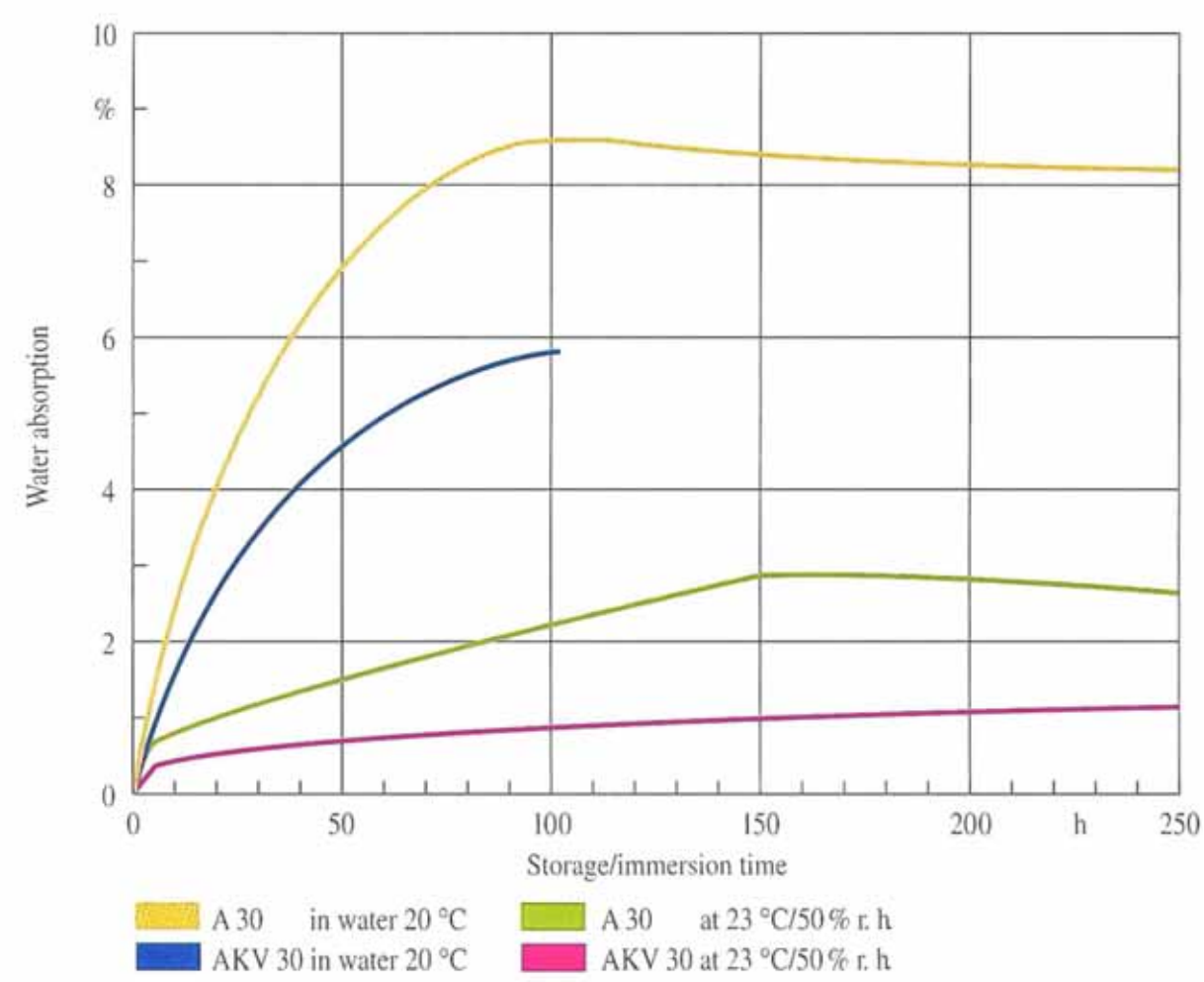
Water Absorption Behavior

Figure 2: Water Absorption of Durethan A (2 mm wall thickness) as a function of storage time.



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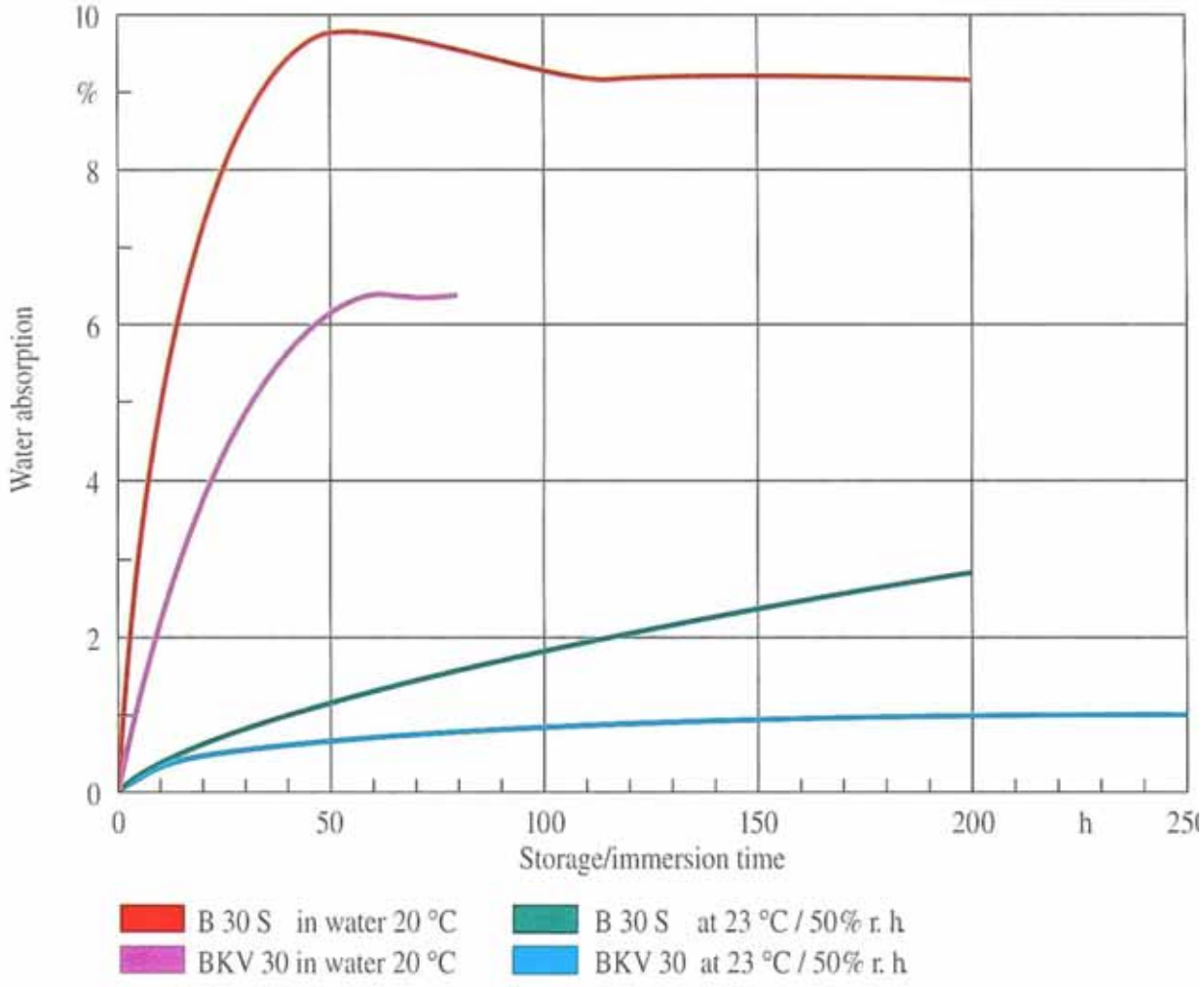
Water Absorption Behavior

Figure 3: Water Absorption of Durethan B (2 mm wall thickness) as a function of storage time.



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Water Absorption Behavior

Grade \ Relative humidity in %	30	56	62	95	Immersion in water
A 30/A 31	0.9	2.1	2.7	7.8	8.3
AKV 30	0.6	1.5	1.9	5.2	5.8
KU 2-2511/30[1)]	—	—	1.3	2.9	3.8
B 30 S/B 31 SK	1.2	2.4	3.1	9.0	9.7
BKV 30	0.8	1.6	2.2	6.0	6.4
BKV 30 RM[1)]	—	—	1.6	3.1	3.9

[1)] RM grade = grade with reduced moisture absorption

Table 1: Equilibrium water contents (in %) of Durethan grades on storage in a humid climate and immersion in water.

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Water Absorption Behavior

- PA 6 absorbs slightly more water than PA 66
- Elastomer/mineral modified or glass fiber reinforced

  → *Water absorption depends on PA component*

- Durethan RM grades

  → *special product for low water absorption*

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Determining the Water Content

- Weight parts before and after conditioning
- For unknown initial water content
  - → *Drying in a vacuum at 75 °C*
  - → *Measure initial and final weights*
- By differential vapor pressure
  - → *Heat parts in closed, evacuated vessels at 200 °C*
  - → *Measure increase in partial pressure*
- By volumetric titration (DIN 53715)
  - → *Karl Fischer Method*

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Effect of Water Absorption on Molded Parts

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Effect of Water Absorption on Molded Parts

Change in Mechanical Properties

Dimensional Change

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Change in Mechanical Strength

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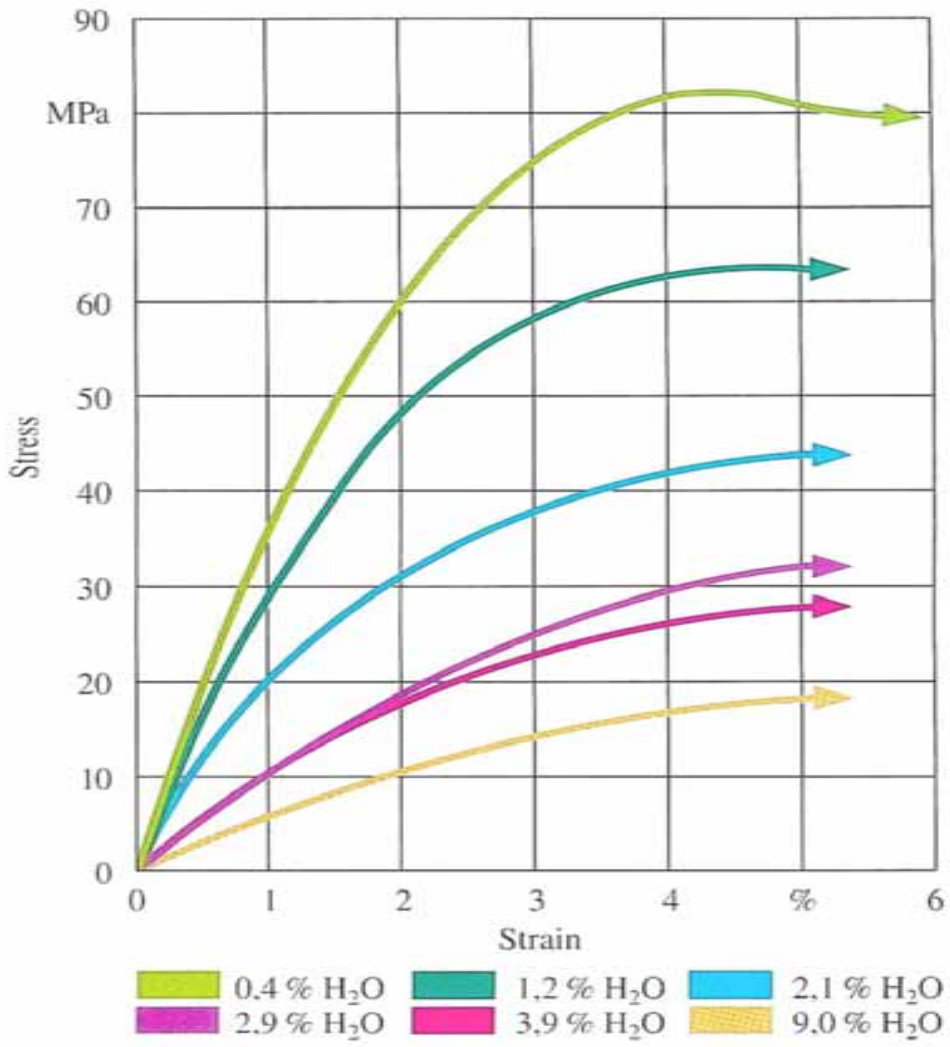
Changed Mechanical Properties

Figure 4: Stress-strain diagram from the tensile test to ISO 527 for Durethan B30 S with different water content



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Changed Mechanical Properties

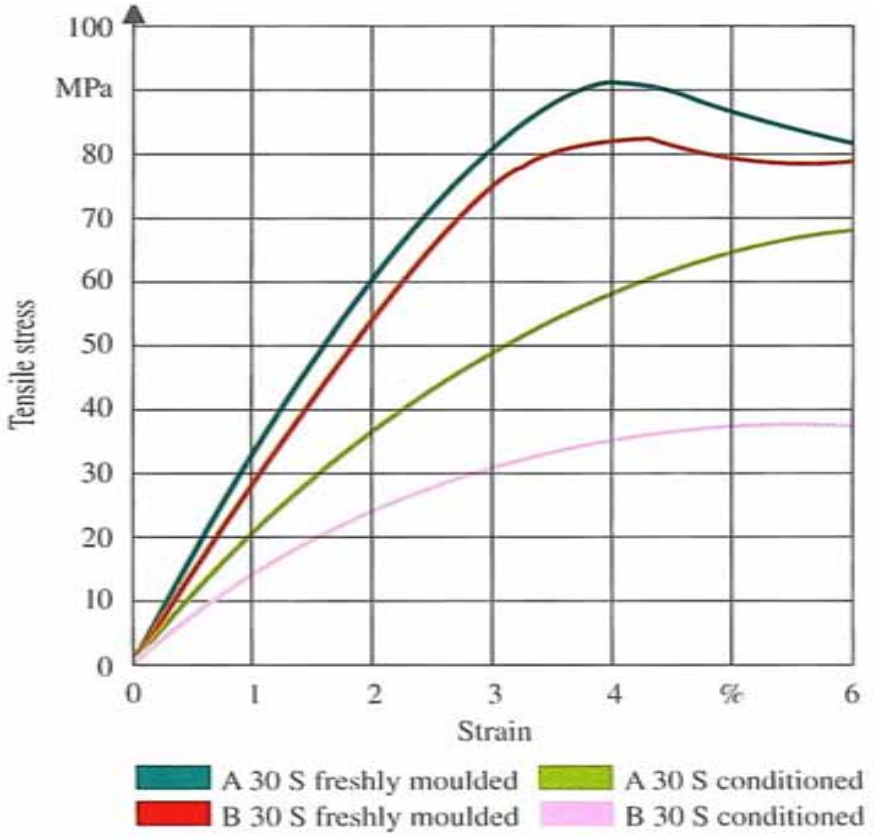

Figure 5: Stress-strain diagram to ISO 527 and DIN 53455 for Durethan B30 S and Durethan A30 S in the freshly molded and conditioned states (conditioned in accordance with ISO 1110)

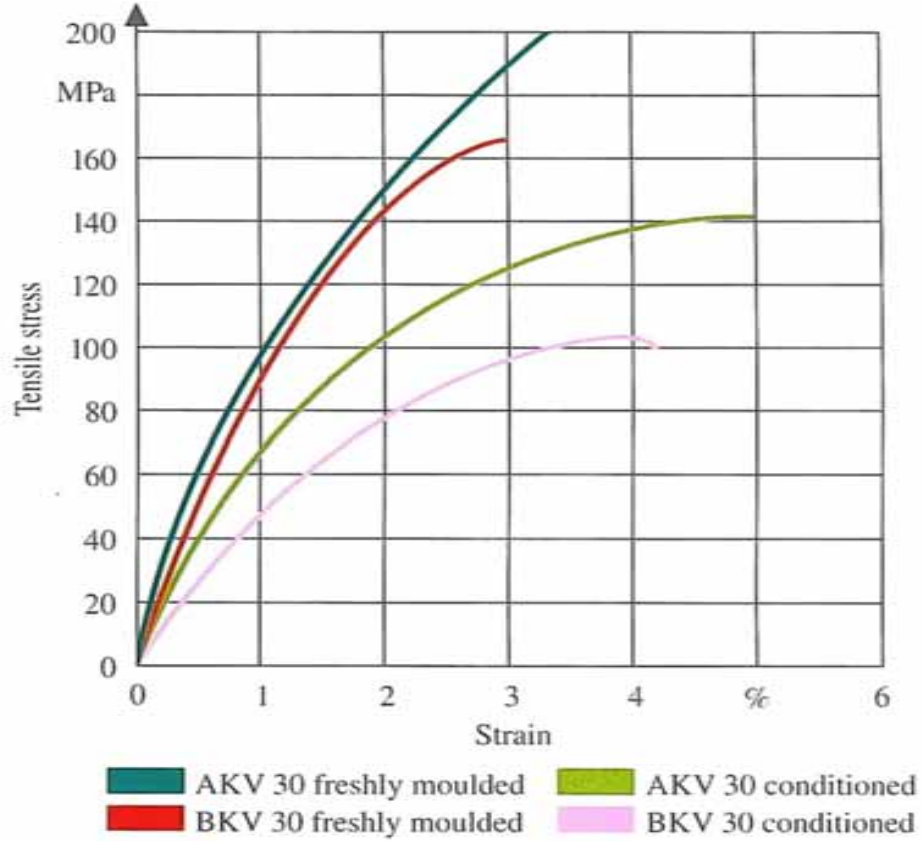

Figure 6: Stress-strain diagram to ISO 527 and DIN 53455 for Durethan BKV30 and Durethan AKV30 in the freshly molded and conditioned states (conditioned in accordance with ISO 1110)

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Dimensional Change through Water Absorption

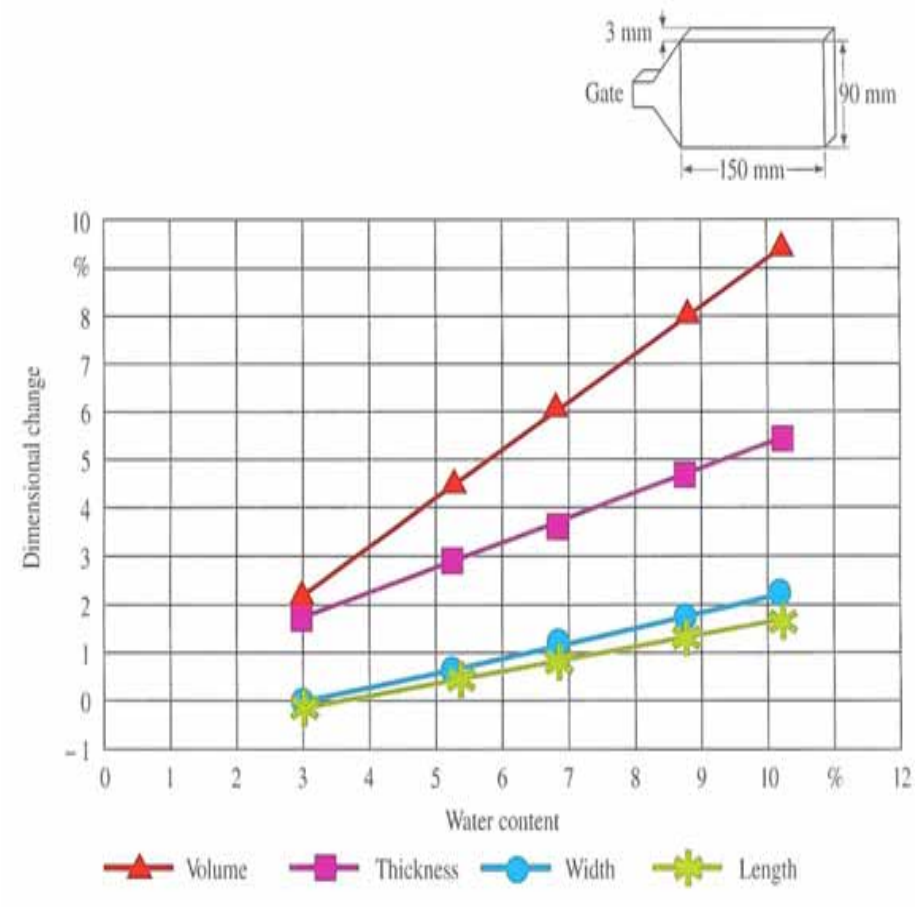

Figure 7: Dimensional change in rectangular specimen (150 x 90 x 3 mm) in Durethan B30 S injected from the front end.

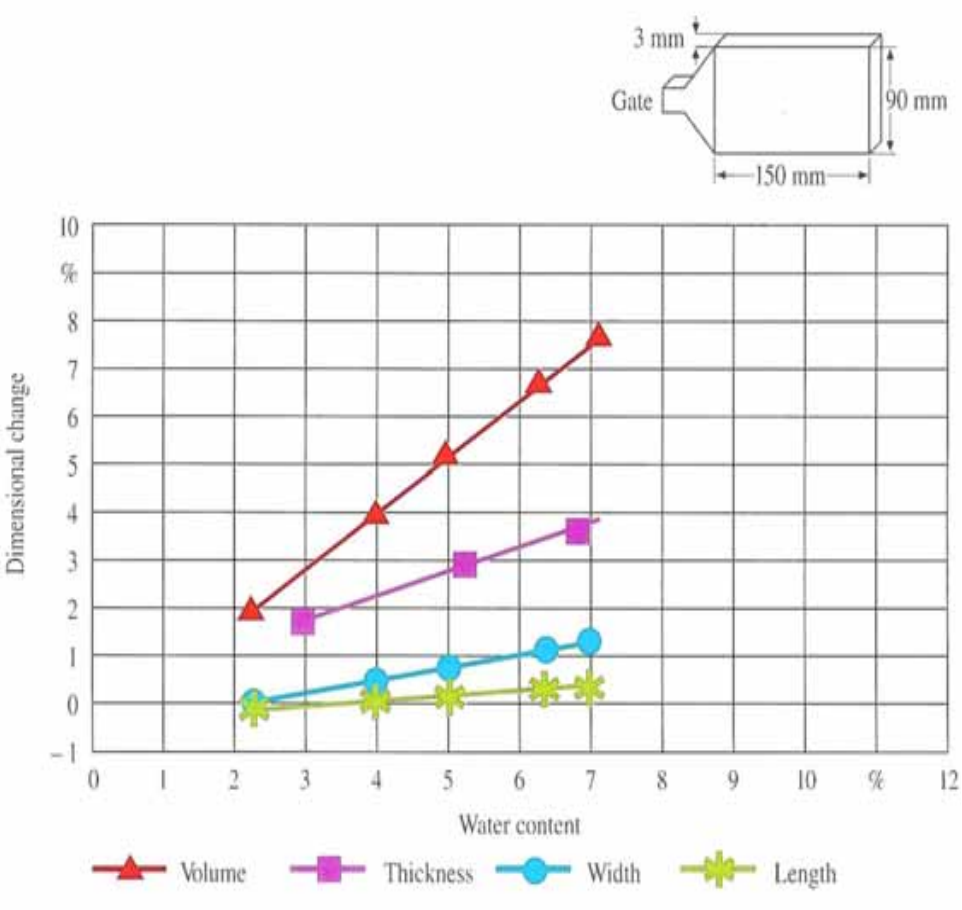

Figure 8: Dimensional change in rectangular specimen (150 x 90 x 3 mm) in Durethan BKV30 injected from the front end.

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Conditioning

Factors Affecting Water Absorption

- Material type (degree of saturation, diffusion index)
- Time
- Temperature (affects diffusion index)
- Parts geometry (particularly wall thickness)

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Conditioning

Method	Conditions	Advantages	Drawbacks	Applications
Tropical climate	40 °C, 90 to 95 % relative humidity	gentle action, particularly for coloured grades of Durethan BKV and Durethan AKV	high plant costs	power tools, vacuum cleaner housings
Immersion in hot water	80 to 90 °C	rapid	discoloration through oxidation, water stains	plugs, casters, etc.
Immersion in warm water	60 °C	sufficiently rapid and **recommended**		as above
Immersion in cold water	20 to 40 °C	inexpensive	amount of time required	frequently used for large mouldings, such as seat shells
Packaged in a PE bag	RT with addition of 2 to 5 % water	low-cost	uncontrolled moisture content	frequently used for miscellaneous small parts
Saturated steam	95 to 100 °C, 100 % relative. humidity	rapid	discoloration through oxidation, deposit formation, tendency to warp	thick-walled parts
Defined immersion time	RT, ambient humidity	almost neutral as regards costs	uncontrolled conditions	any application, providing immersion time is sufficient
ISO 1110	70 °C, 62 % relative humidity	conforms with the Standard		only for test specimens

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