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Engineering Thermoplastics  
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## *Proper Material Handling Procedures For Nylons*



**This guide is intended to create a better understanding and of the importance of material handling and moisture content and it's effect on processing and finished parts.**

**The scientific side of the moisture phenomenon:**

**Nylon products are hygroscopic materials by nature. Although all polymers absorb moisture at some level, none of them have more of a significant effect as nylons. Water molecules produce polar bonds with the amide groups in the nylon molecules. Although small, water molecules take up space and displace nylon molecules. The increase in spacing between nylon molecules due to HIGH moisture content has a negative effect on properties.**

**When processing nylons with moisture content of higher then 0.20% the result can be a hydrolytic degradation and significant loss of properties. Hydrolytic degradation is a chemical reaction that occurs at high temperatures with some polymers in the presence of water (i.e. Nylons). This causes primary bonds in the molecular chains to be severed thus reducing molecular weight.**

**On the other end of the moisture spectrum is over-drying (<0.05%). Nylon materials need a small amount of moisture for greater flow characteristics. The moisture acts as a plasticizer and when not present will create a more viscous material that will not flow as well. This can cause under filling (shorts) and part brittleness.**

**Therefore, as you can see, the importance of material handling and proper drying can have a great impact on your processing and the properties of the finished parts.**

**In plain English (What all this really means on the production floor):**

**High moisture can have a negative effect not only on processing but also the finished part properties.**

*You cannot always see high moisture when processing.*

**Yes, if moisture is high enough you will see drooling, spitting out of the nozzle, stringing and process inconsistencies. However, there is a range between 2% - 3% where you may not see any of the problems mentioned above and still produce less then optimized part quality. You may see part brittleness, surface roughness or actual voids if the part is cut open.**

**If moisture content is to low, you should notice an increase in the pressures needed to fill the cavity. The material becomes more viscous without water molecules having the plasticizing effect in the material. This can lead to insufficient packing of the part and may also cause brittleness, under sized parts and less then optimized properties.**

*It is of utmost importance to know the moisture level when processing nylons.*

**This is greatly overlooked in the plastic industry and can save you hours of frustration and greatly reduce your loss in profit due to scrap and time spent troubleshooting issues brought on by improper moisture content.**

*Where do you start? What are the best procedures for material handling moisture sensitive materials?*

***Material handling when received:***

Material packaging should be visually checked to insure no damage has occurred during shipment. Any damages to boxes or bags should be corrected immediately to minimize moisture absorption. Boxes or bags should remain sealed until material is loaded into the dryer.

***Drying materials prior to processing:***

The use of a moisture analyzer is highly recommended. Even though materials are shipped at suitable moisture ranges they can still absorb sufficient moisture in a very short time that exceeds recommended moisture levels. It is recommended that a moisture analyzer be utilized prior to drying to insure the proper time is selected, therefore avoiding over or under drying of materials. Periodic checks through the drying process are also helpful.

This is a very important point made in the above paragraph. The key to controlling moisture is *attention to detail*. Even though this adds a small amount of work into the process it can produce significant gains in production numbers and lower scrap rates due to better processing and part consistency. The moisture analyzer will ensure your drying the materials to optimum levels. Moisture can vary in materials that are shipped and you need to know what level of moisture they are at *prior* to drying to determine time needed for sufficient drying without over drying. This may have to be determined with a number of DOE studies due to dryer capabilities to optimize the procedure for your equipment.

***Drying Equipment Recommendations:***

For optimum drying a closed loop desiccant dryer is recommended. Dryers should provide uniform and even distribution of air through the hopper. Recommended airflow through the hopper is one cubic foot of air per minute for every pound per hour of use. If 100 lbs. of material are consumed per hour, the airflow to the hopper should be 100 cubic feet per minute.

Below are guidelines for using and maintaining dryer systems:

- Clean the filters on the dryer on a regular basis to ensure that specified air flow is maintained
- Change and maintain the desiccant in the dryer per the manufacturer's recommendations
- Using a dew point meter, check air entering the hopper. The dew point should range between -20°F and -40°F.

***Hot air dryers are NOT recommended for hygroscopic materials. These dryers can add moisture to the material by introducing moist air into the hopper and do not have enough air circulation to dry internal moisture out of the materials.***

### How to calculate residence time in dryer

To perform this calculation, the following variables are needed:

1. Total shot weight (including sprue and runner)
2. Total cycle time
3. Total dryer capacity

These values can be used in the equations below:

$$\frac{\text{Shot weight (Lbs)}}{\text{Total cycle time (sec)}} \times 3600 = \text{Dryer Thruput rate (Lbs hr)}$$

$$\text{Total dryer capacity (Lbs)} \div \text{Dryer thruput rate (Lbs hr)} = \text{Residence time in dryer}$$

### *Handling of material during production:*

All boxes or bags should be sealed in some way as to allow material pick up but minimize moisture penetration. This may be as simple as cutting a hole that the material wand will fit into and then applying tape around the bag or liner and tube to seal out the moisture. They also sell Gaylord covers that are reusable and seal out moisture, dust and contaminants. This is an investment that will pay for itself over time.

In colder months where material is subjected to colder temperatures during storage it should be allowed to achieve room temperature for 1-2 hours prior to opening so condensation does not form on the pellets

### *Drying of Nylons*

As mentioned in the above section, a moisture analysis should be conducted prior to drying to determine the drying time needed. Figure 1A shows recommended moisture content levels (by weight).

Product	Recommended Moisture Content (by weight)
Unreinforced Homopolymer	0.05% - 0.20%
<20% Reinforced	0.05% - 0.16%
>20% Reinforced	0.05%– 0.12%

Figure 1A

### ***Drying Regrind***

**If regrind that is not fed directly back into the molding process will collect moisture. If the regrind particle size is larger than the virgin pellets it is difficult to dry them together due to surface area differences. Regrind will collect more moisture if surface area is larger than that of the virgin pellets and in turn will take longer to dry. It is recommended to dry regrind off line to prevent moisture content differences with regrind and virgin materials.**

### ***In Summary***

- **The correct drying procedure for nylons is critical to part performance and processing.**
- **Many processing issues can be traced back to incorrect moisture content in the material**
- **Knowing the moisture content prior to drying is critical to proper drying times**
- **Proper maintenance on dryer units should be completed regularly and sufficiently to ensure units are working at 100%**
- **The drying recommendations from the manufacturer are guidelines only and a moisture analysis should be used to define time needed for drying**
- **A moisture analyzer is a critical piece of equipment when processing nylons**