Fill Power testing has undergone dramatic changes during the past 10 years. These changes have all helped to improve the reliability and reproducibility of fill power testing.

Two main questions are always asked by buyers of bulk down and feathers as well as finished products:

1. **What is the original fill power of the bulk down and feather filling material that we purchased?**

2. **What is the “usable” fill power of the down and feathers that the end consumer will experience while using the product?**

Many different measuring systems and cylinders exist to measure fill power:

- IDFB/Lorch mm/30g
- IDFB/Lorch cubic inches per ounce
- EN 12130 mm/20g or cm3/g
- USA Cylinder cubic inches per ounce
- JIS Cylinder cm/30g
- China GBT Cylinder cm/30g

All of the above systems can normally be converted to the approximate value of another system with standard factor tables.

However, the most critical part of fill power testing is the conditioning method. Any of the conditioning methods can be used with any of the cylinders and measuring systems. Most countries and regions specify which conditioning method should be used with which cylinder.

The next two pages describe the conditioning methods and the chemical/physical reasons why conditioning is important for testing fill power.
**Brief Explanation of the six different conditioning methods**

1. **No Conditioning**
   Down processors often use no conditioning to measure fill power immediately after washing and sorting down & feathers.

2. **Oven Heating**
   The Chinese GBT conditioning method for fill power requires down to be heating at 70°C for 45 minutes and then conditioned in a textile climate room 24 hours before testing.

3. **Box Conditioning**
   Down and feathers are placed in a conditioning box for 72 hours in a textile conditioned room (20°C ±2°C and 65% RH ±4%)
   
   This conditioning method has been used for decades. Most test methods including EN 12130 and IDFB have required this conditioning method for many years.

4. **Tumble Dry**
   IDFL developed the tumble dry conditioning method in 1996. IDFL published initial results of our research in January 1997.
   
   In 1999, the IDFB officially adopted the tumble dry conditioning method as part of its fill power method. Europe also adopted the tumble dry method in the PAS 1003 document in 1999.

5. **Water Rinse**
   IDFL developed the water rinse conditioning method in 1996 and published results of our research in 1997. IDFL proposed that IDFB adopt the water rinse method for jackets and sleeping bags in 1999. IDFB did not approve the water rinse method because of the possibility of altering the down material during washing.

6. **Steam**
   Japan developed a steam conditioning method in 2004. IDFL and the Japanese down and feather association developed a revised steam method during 2005. The IDFB Technical Committee voted to adopt the steam conditioning method during the Kyoto IDFB meetings in June 2005.

**The Interaction of Down and Feathers with Moisture and Temperature**

Down and Feathers (chemically very closely related to human hair) consist of natural macromolecules. These are based on proteins, which, in turn, are assembled of various amino acids. The entire family of these organic chemicals work in a physical-chemical interaction with water molecules. As for down and feathers, the moisture content reaches an equilibrium of approximately 11% at close to standard climate conditions (23°C and 60% relative humidity).
The natural construction (3-dimensional arrangement of molecules) of each individual down or feather has a very stable form. Unless chemically or thermally mistreated, no matter how hard the down is twisted or compressed, it can (like naturally curly hair) return to its original form. In metallurgy this phenomenon is known as “memory effect”. In the case of the protein macromolecules (the building blocks of down and feathers), warmth and moisture support this (re-)activation of the structural memory.

When customers use a duvet, a sleeping bag or a down jacket they exude moisture and warmth and the down cluster “opens up”. This helps to increase the insulation value of the product, which may have been hard compressed for a long period of time. Customers may become more happy with the new duvet after use. The effect may continue after the first use and improvement may occur after 2 or 3 nights.

For this reason, in quality testing, the final readings of fill power are usually measured after 3 to 4 days. For the same reason, and to simulate this positive human influence on the fill power or loft of a down product, various conditioning method were developed.

**Development of conditioning methods to mimic use of down by consumers**

The Tumble Dry conditioning method developed by IDFL 12 years ago was a big step in the development of a method to accurately measure the insulation capability of down and feather products. In 1996, IDFL also proposed the water rinse method, because some products (especially compressed jackets and sleeping bags) did not respond properly to tumble dry.

An old rule of thumb states that the tempo of a chemical reaction is accelerated by a factor of 2 with each 10°C raise in temperature. Down and feathers are washed and dried at high temperatures. Original Fill Power is determined by the fill power test that occurs immediately after washing and sorting at the down factory.

The industry has always searched for a method that could reproduce the original fill power at the down factory. Tumble Dry was a great improvement over the box conditioning method. However, Tumble Dry was not entirely successful at reproducing fill power for products that had been compressed for several weeks during shipment.

Japanese manufacturers worked to find a method for reproducing the original fill power that was tested at the down and feather washing factory. This goal was achieved by applying a concentrated form of moisture (steam) and higher temperature (hot steam).

IDFL began a series of several thousand tests comparing original fill power with fill power after various shipping and compression techniques. IDFL baked down for several hours, compressed down with 1000 pounds of pressure and repeatedly washed down products. IDFL vacuum packed products for several weeks. After all the thousands of tests IDFL came to the conclusion that the Japanese steam method was the only method that successfully reproduced the original fill power value regardless of the harsh handling, shipping and compression of finished products.
Which Fill Power Conditioning method is the most accurate?

This is a good question. The answer is in two parts.

**Original Fill Power**
The steam conditioning method is the only method that will accurately reproduce the original fill power of down and feathers regardless of the shipping, compression or other handling. (Original fill power is defined as the fill power tested immediately after washing and sorting at the down factory.)

**Usable Fill Power**
The usable fill power is a very difficult value to determine. Many factors might influence the usable fill power. Some factors outside of the filling include:
  - Filling Density of the finished product
  - Product construction
  - Fabric type
  - Use of additional fabric covers for duvets and pillows.

The following chart outlines the reliability of three conditioning methods for determining original fill power and “usable” fill power.

<table>
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<tbody>
<tr>
<td>No Conditioning</td>
<td>Down Processing Factory normally uses no conditioning when measuring fill power after washing and sorting. “No conditioning” will never give accurate original fill power values after shipping.</td>
<td>“No conditioning” will give an accurate usable fill power for any point in time. However, the fill power value will change dependent on climate conditions and use of the product. Without conditioning, fill power is always a changing value and never reproducible</td>
</tr>
<tr>
<td>Oven Heating Conditioning (Chinese GBT method)</td>
<td>This method will not give accurate original fill power values.</td>
<td>This method gives similar results as Box Conditioning. In some cases results are lower. This method might give a “usable” fill power before customer use. The heating method allows a shorter conditioning period before testing is completed.</td>
</tr>
<tr>
<td>Box Conditioning Method</td>
<td>This method will not give accurate original fill power especially if the product has been compressed.</td>
<td>Box conditioning might give a “usable” fill power before customer use. However, the method will not give an accurate reading of fill power after a customer sleeps under the duvet or in the sleeping bag. The fill power reading can vary depending on how the product was shipped and handled before testing.</td>
</tr>
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The following chart compares the reliability of Tumble Dry, Water Rinse and Steam Conditioning to determine both original fill power and “usable” fill power.

<table>
<thead>
<tr>
<th>Conditioning Method</th>
<th>Evaluation of Accuracy for Testing Original Fill Power</th>
<th>Evaluation of Accuracy for testing Usable Fill Power</th>
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<tbody>
<tr>
<td><strong>Tumble Dry</strong></td>
<td>Tumble Dry fill power tests will give a result much closer to original fill power than Box Conditioning. Tumble Dry gives close to original fill power results for bedding products that have not been compressed during shipment. Tumble Dry gives less than the original fill power results for compressed bedding products and most jackets and sleeping bags.</td>
<td>Tumble dry is a good indicator of “usable” fill power. The tumbling with a damp cloth simulates customer effect on down during use (sleeping or wearing a jacket). However, IDFL research on thousands of samples shows that Tumble Dry gives different results on identical products which have been held under different storage conditions (humidity, compression) for an extended period of time. For example, if a company washes a jacket before sending it to a testing lab – the tumble dry fill power result will be higher than for the same jacket sent to the testing lab unwashed. The repeatability of fill power measured on different products with comparable filling materials is much better than box conditioning. However tumble dry can be manipulated by the handling of a product before arriving at the testing laboratory. Tumble dry fill power favors products made locally, compared with overseas shipments (even if down filling is identical.)</td>
</tr>
<tr>
<td><strong>Water Rinse</strong></td>
<td>The Water Rinse method gives a fill power value that matches very close to the original fill power.</td>
<td>The Water Rinse method gives an accurate “usable” fill power value for a product that matches the fill power after a customer washes and cleans a down and feather product.</td>
</tr>
<tr>
<td><strong>Steam</strong></td>
<td>The Steam Conditioning method is the most accurate method to determine the original fill power value. (Original Fill Power is the fill power test completed by the down processing factory immediately after washing and sorting.)</td>
<td>The Steam Conditioning method gives an accurate “usable” fill power that matches fill power tested after a finished product is cleaned and washed. The question still remains: <strong>Does tumble dry or steam conditioning give the most accurate “usable” fill power during customer use?</strong>  <strong>The answer to this question is still open.</strong> Steam conditioning gives a more consistent result regardless of product handling before sending to the test lab. Although tumble dry fill power may better reflect the actual consumer experience, values can be manipulated by different handling of products before sending to the test lab. (See next page for additional information)</td>
</tr>
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</table>
Additional information for rating tumble dry and steam conditioning methods

Steam Conditioning is the only accurate method to determine the original fill power. This test should be done to verify the fill power of bulk down purchased from the factory.

Evaluating “usable” fill power is more complicated. Additional research is needed before any definitive statement can be made about which method gives a more “usable” fill power rating.

The following information should be considered when evaluating the conditioning methods:

- Both the tumble dry and steam methods add moisture and heat to the down and feathers.

- Several thousand test results have since proven that steam conditioning does NOT falsely inflate the fill power beyond its natural, original structural value.

- The steaming process “adds” moisture and heat to the down during steaming. The down is immediately revived with warm, dry air. This process simulates the factory washing process of bulk down and the consumer washing of finished down products.

- The tumble dry process also “adds” moisture and heat to the down during the tumbling with a damp cloth. The down is moderately “steamed” and revived as the cloth is dried.

- The steam method revives to a steady state as early as 24 hours after conditioning. The tumble dry method requires 72 hours to revive to a steady state.

- Both tumble dry and steam maintain a steady state fill power after conditioning for many days. IDFL tested material several months after conditioning and found little decrease in fill power.

- The tumble dry method can be manipulated by handling of products before shipping to the test lab.

- The steam method appears to give similar results regardless of the handling of the product before arrival at the test laboratory.

Conclusions

Steam Conditioning is the only consistent, reproducible method of determining the original fill power.

“Usable” fill power is still an open question. Additional discussion and research are needed.

Four possible options are possible in the answering the question: What is “usable” fill power?

1. Use Tumble Dry to determine “Usable” Fill Power.
2. Use Steam to determine “Usable” Fill Power.
3. Use a combination of Steam and Tumble Dry to determine “Usable” fill power.
4. The industry may determine that “Usable” Fill Power, is too difficult, if not impossible to measure.

Even though IDFL developed the Tumble Dry method, IDFL tends to support the Japanese-developed steam method as the basis for determining “Usable” fill power.

IDFL encourages further discussion among both IDFB and national down and feather associations to determine if “Usable” fill power can or should be measured and by what method.