Fitzroy's Storm Glass

Weather Instrument Used on Darwin's Ship the HMS Beagle

Admiral Fitzroy (1805-1865), as commander of HMS Beagle, participated in the Darwin Expedition from 1834-1836. In addition to his naval career, Fitzroy did pioneer work in the field of meteorology. The Beagle's instrumentation for the Darwin Expedition included several chronometers as well as barometers, which Fitzroy used for weather forecasting. The Darwin Expedition also was the first voyage under sailing orders that the Beaufort wind scale be used for wind observations.

One type of barometer used by Fitzroy was a storm glass. Observing the liquid in the storm glass was supposed to indicate changes in the weather. If the liquid in the glass was clear, the weather would be bright and clear. If the liquid was cloudy, the weather would be cloudy as well, perhaps with precipitation. If there were small dots in the liquid, humid or foggy weather could be expected.

A cloudy glass with small stars indicated thunderstorms. If the liquid contained small stars on sunny winter days, then snow was coming. If there were large flakes throughout the liquid, it would be overcast in temperate seasons or snowy in the winter. Crystals at the bottom indicated frost. Threads near the top meant it would be windy.
Here are instructions for constructing a storm glass, described by Pete Borrows at NewScientist.com and in School Science Review, June 1997.

Ingredients for Storm Glass

- 2.5 g potassium nitrate
- 2.5 g ammonium chloride
- 33 mL distilled water
- 40 mL ethanol
- 10 g camphor

Dissolve the potassium nitrate and ammonium chloride in the water; add the ethanol; add the camphor. Place in corked test tube.

Mark Ford, who has been making storm glasses for years, e-mailed me to add that man-made camphor, while very pure, does contain borneol as a by product of the manufacturing process. His experience is that the synthetic camphor doesn't work as well as natural camphor, perhaps because of the borneol.

Mr. Ford advises dissolving the nitrate and ammonium chloride in the water, then the camphor in the ethanol. Next, slowly mix the two solutions (adding the nitrate & ammonium solution to the ethanol solution works best). It also helps to warm the solution to ensure complete mixing. Mr. Ford never uses a cork, preferring to seal the mixture in small glass tubes.

No matter what method is selected to construct a storm glass, the reader is advised to use proper care in handling the chemicals.

The premise of the functioning of the storm glass is that temperature and pressure affect solubility, sometimes resulting in clear liquid; other times causing precipitants to form. The functioning of this type of storm glass is not fully understood. In similar barometers, the liquid level, generally brightly colored, moves up or down a tube in response to atmospheric pressure. Certainly temperature affects solubility, but sealed glasses are not exposed to the pressure changes that would account for much of the observed behavior. Some people have proposed that surface interactions between the glass wall of the barometer and the liquid contents account for the crystals. Explanations sometimes include effects of electricity or quantum tunneling across the glass.

Italian mathematician/physicist Evangelista Torricelli, a student of Galileo, invented the barometer in 1643. Torricelli used a column of water in a tube 34 ft (10.4 m) long. Storm glasses available today are less cumbersome, easily mounted on a wall.
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When Robert FitzRoy took *HMS Beagle* out on its second voyage in 1831, he carried a number of different barometers. Among the studies FitzRoy undertook on the voyage was the application of the various barometers and storm glasses in widespread use during the 1800s to weather forecasting at sea.

Barometers, of course, are instruments designed to measure atmospheric pressure, and that pressure, or more correctly the changes in air pressure, are important in short-term weather forecasting. A few decades after *Beagle*'s return, FitzRoy would be instrumental in placing barometers and instructions for their use around the British coastline.

One type of storm glass is a form of barometer that does not show absolute pressure but indicates changes in air pressure over time. They are generally a glass vessel looking like a stretched teapot sealed at one end and filled with water, usually colored for visibility. Known by many names including the *weather glass* and *water barometer*, it offers an aid to simple weather forecasting by showing pressure changes as water rises or falls in its "spout." I have written about this form of storm glass elsewhere: "The Weather Glass" available at [www.islandnet.com/~see/weather/almanac/arc2004/alm04mar.htm](http://www.islandnet.com/~see/weather/almanac/arc2004/alm04mar.htm)
The form of storm glasses with which FitzRoy is linked is much different. These chemical storm glasses, also known as storm bottles, are hermetically sealed glass tubes containing a supersaturated mixture of chemicals. They likely appeared around 1750 invented by an alchemist for Italian sailors. The instrument was mounted on the ship's mast as a storm warning instrument. Their first documented shipboard use dates to the Beagle's famed 1831-36 circumnavigation. FitzRoy wrote in The Weather Book: "Considerably more than a century ago, what were called 'storm glasses' were made in this country. Who was the inventor, is now very uncertain; but they were sold on old London Bridge..." in the shop "Under the Goat and Compasses."

The premise of the storm glass is that changing weather, affects the solubility of the mixture, mostly due to changes in temperature. (Some believe changing pressure alters the storm glass mixture, but if the glass tubes are sealed, the pressure within should not change with variations in atmospheric pressure.

Under the changing weather conditions, users believed, the super-saturated mixture of chemicals produced crystals in strange, fascinating organic and crystalline shapes, or alternately, existing crystals would melt back into solution. The functioning of the storm glass is, however, not fully understood even today, and they are now more a curiosity than a practical instrument.

To quote from his 1863 tome The Weather Book:

"Since 1825 we have generally had some of these vials...when it was fairly demonstrated that if fixed, undisturbed, in free air, not exposed to radiation, fire, or sun, but in the ordinary light of a well-ventilated room, or preferably in the outer air, the chemical mixture in a so-called storm glass varies in character with the direction of the wind — not its force... though it may so vary from another cause, electrical tension. As the atmospheric current veers toward, comes from, or is only approaching from the polar direction, this chemical mixture — if closely, even microscopically watched — is found to grow like fir, or fern leaves — or like hoar frost — or even large but delicate crystallisations..."

FitzRoy found one specific mixture, containing camphor, ammonia, alcohol, potassium nitrate, and water, more suitable for weather forecasting than others. In The Weather Book, FitzRoy described the various crystal shapes and patterns that would develop within the storm glass according to different wind directions and weather conditions.
Clear liquid means bright weather; dim liquid, rain. Crystals at the bottom presage frost. Large flakes mean overcast or, in winter, snowy skies. If the liquid contains small dots, humid or foggy conditions can be expected.

As its name implies, many believed the instrument was especially sensitive to the coming of stormy weather. Thus, if small stars are seen in dim liquid, thunderstorms can be expected. Threads in the upper part foretell wind. If the substance lies to one side, expect storm or wind from the opposite direction.

FitzRoy included a storm glass as part of the FitzRoy barometer assembly. These barometers were distributed to every British port so that it could be consulted by seamen before embarkation. Many of these stone huts housing these mercury barometers are still visible in many fishing harbors. The storm glass, glass cylinders with brass caps, can be seen clamped onto the lower left of the barometer assembly.