



Digital thermometers
Photos courtesy of the author
unless otherwise stated

Continuing the series on 'Aquarium Essentials' – the basic equipment that we all need - our technical writer, Dr David Ford, looks at thermometers

Some like it hot!

We are a *Tropical Fish* magazine, which means the aquariums we study need to be heated. The majority of popular tropical freshwater fish come from the Amazon, where the average temperature all year round is 80°F (as the locals call it) or (about) 27°C. The marine tropicals are mainly coralfishes and their seawater temperatures are very stable at a similar value. For example, the Great Barrier Reef has a surface water temperature of 27°C/80°F but the Northern part of the Red Sea is 26°C/79°F, whereas the Southern part is 30°C/86°F.

This is why we need to heat our tropical tanks, even in centrally-

heated homes, and the recommended temperature is within the range 24°C/75°F and 26°C/79°F. This is for the typical community aquarium with mixed species. If you keep a species tank, you need to discover the preferred temperature of the fish (especially if breeding – fish eggs are very temperature dependant).

Every aquarium, even coldwater ones, need a thermometer because fish are ectotherms i.e. cold-blooded. They do not generate internal heat (like their owners) and so depend on the water temperature for their body temperature. A thermometer checks that these values are within the correct range for the fish to be happy and healthy.

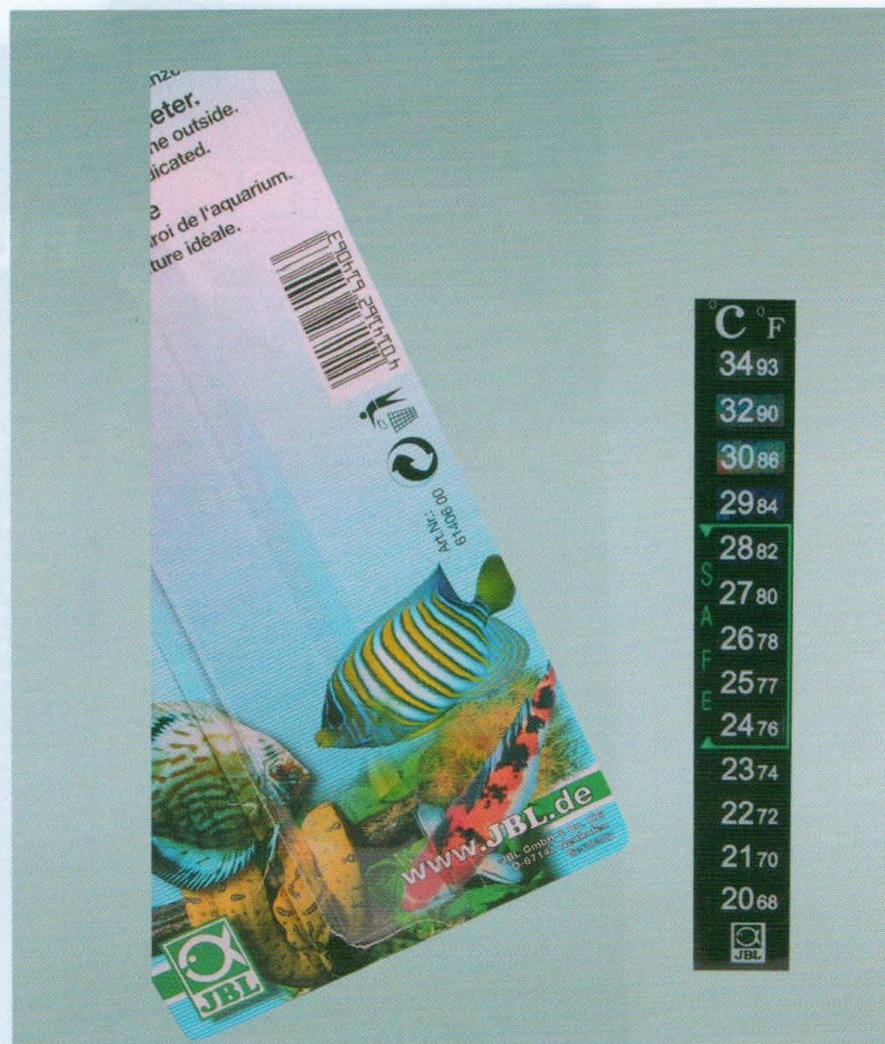
Where it all began... a history

The thermometer began life as the Thermoscope in the 1600s, invented by a chemist called Galileo Galilei in Vienna. It had glass spheres filled with coloured water-alcohol mixtures floating in a sealed glass tube full of pure water. The spheres moved up or down according to the ambient temperature. Pretty, but not very accurate.

A medical doctor colleague called Santorio Santorio added a scale to the Thermoscope and so the thermometer was born. The scale was arbitrary but made precise by a German Physicist called Gabriel D. Fahrenheit in 1724. He chose an ice water mix as the lower value and ▶



Meter readers



Conversion chart

If you like maths (or use a calculator) convert °F to °C by subtracting 32 and multiplying by 0.556. For °C to °F multiply by 1.8 and add 32

The normal range for the home aquarium is:

C	F	F	C	F	C
21	69.8	70	21.1	80	26.7
22	71.6	71	21.7	81	27.2
23	73.4	72	22.2	82	27.8
24	75.2	73	22.8	83	28.4
25	77.0	74	23.4	84	28.9
26	78.8	75	23.9	85	29.5
27	80.6	76	24.5	86	30.0
28	82.4	77	25.0	87	30.6
29	84.2	78	25.6	88	31.1
30	86.0	79	26.1	89	31.7

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boiling water as the higher one. For unquoted reasons he decided to divide the difference by 180, with 32 being the freezing point and so 212 the boiling point of water. Hence the

Fahrenheit scale was published and adopted by the scientific community – for a while.

In 1742 Anders Celsius, a Swedish Astronomer, decided to metric the scale and chose 0 for the freezing point and 100 for the boiling point. He called it a Centigrade scale, which literally means (in Latin) 'divided into

100 degrees'. This was preferred by the scientific community and replaced the Fahrenheit scale, but only in their publications.

What it meant for the hobby

The Aquarium hobby began in the 1800s and so chose the Fahrenheit scale – which is still used to this day. With metrication, especially in Europe, the Centigrade scale became increasingly used whereas in America for colonial reasons, they stayed with Fahrenheit. This has given rise to aquatic publications quoting both values - and all aquarium thermometers having both scales thereon.

As usual, things are even



Every tank should have a thermometer. Photo courtesy of IBL



Glass thermometers



The choice for the aquarist is very great in these technical times – but whatever system is chosen they are all precise and accurate

more complicated. 'Centigrade' means degrees of a circle in Spanish so their scientists had a problem, solved by the EU choosing 'Celsius' after inventor Anders Celsius as the preferred name.... the units remain the same. This is a step too far for the aquarist, so we still quote Centigrade and/or Fahrenheit for the fish's world, but Celsius for our world (unless you are American!).

Furthermore, when physicists understood the nature of heat (it is simply the vibration of molecules) they decided that a scale based on this property was best. Lord Kelvin (actually Sir William Thomson, Baron Kelvin of Largs, Scotland) did this in 1848 by choosing the lowest temperature possible (when the vibrations cease) as 'Absolute Zero'. In Centigrade this is minus 273.15 (or minus 523.67° F)... there is (so far) no upper limit and the values

are quoted as degrees Kelvin °K. Won't affect aquarists.

Thermometers for our fish tanks

The choice for the aquarist is very great in these technical times – but whatever system is chosen they are all precise and accurate. The traditional thermometer is a glass tube with a Mercury-filled internal bore, but these are becoming rare now that the use of Mercury has been banned by the EU (it can be toxic). The replacement is alcohol stained red or blue with a stable dyestuff (doesn't fade in the light). Both alcohol and Mercury are a 'thermometric' liquids, which means they expand with rising temperature but shrink with cooling, hence the accuracy of the scale readings as the liquid moves up and down the internal tube.

But now we have the digital age where liquid crystal technology is

used to show the numerical values directly. A sandwich of plastic strips holds a 'chiral nematic liquid crystal' – these are long-chain asymmetric molecules that arrange themselves in ordered chains of spirals. When light strikes these chains it is reflected in a particular colour if the light wavelength is the same as the spiral's pitch. As the pitch of the spirals changes with temperature, so the colour of the reflected light changes too. By choosing a particular molecular structure that reflects light at a given temperature, each 'cell' in the strip shows a colour when that temperature is reached. It does not reflect at other temperatures.

Go digital

Digital thermometers are now mass produced in the Far East and so are cheaper than the traditional glass one. They can also 'read' the temperature of the aquarium glass, which is usually the same as the water, and so by adding an adhesive, they can be mounted externally. The liquid crystals change colour from black to



orange, then green, then blue, then back to black as the temperature passes through the cell's particular sensitivity range. The green colour is the value to choose as the true value – but the orange and blue are only 1°F or ½°C apart.

Scientific systems for temperature checking are even available, although expensive they are the most accurate method and useful for hobbyists with fish houses. They use a probe and an electronic meter. Also new are Heater-thermostats that include a temperature read-out using LED display. **FIN**

