

THE SECRETS OF WATER – SCIENTIFIC WORK BY GIORGIO PICCARDI

Autor: Paolo Manzelli, Mariagrazia Costa.

Dirección: Laboratory of Educational Research, Department of Chemistry, University of Florence, Italy.

Water is essential to support life on our planet. In the modern world there is an ever increasing need of water for development. It is however evident that water is not inexhaustible and that future generations may not have enough of it because of the irreversible pollution processes brought about by technology.

Since water has always been regarded as a simple, cheap substance, its characteristics are still little known scientifically.

Giorgio Piccardi (Firenze, 1895-Rimini, 1972) was always a keen observer of the many phenomena related to water (1) (Figure 1). To demonstrate that science had not yet interpreted many phenomena concerning the physical chemistry of water Piccardi would refer to the well-known experiment by Galileo Galilei and called «dell'acqua e del vino» (of water and wine) and described in the «Discorsi e Dimostrazioni Matematiche intorno a due nuove scienze» (Giornata Prima, 1634) written by the great Pisan scientist.

Take two bottles, one full of red wine and one full of water. Make a very small hole in



Figure 1.—Giorgio Piccardi (1895-1972).

the stopper of each bottle. Connect the bottle of water upside down on the bottle of wine and you will see an attractive, surprising phenomenon. The fact that a trickle of wine goes up through the water above without mixing with the latter and that, in the end, the two liquids change place without mixing surprises anybody who may want to carry out Galileo's experiment. Surprise here is due to the unforeseen result. This means that not only in Galileo's times but even now this phenomenon has not been given a simple explanation.

What causes the invisible barrier that prevents the mixing of water and wine which are very similar?

At the beginning of his University courses Piccardi always showed the students some other curiosities related to water. One of them dates back to Aristotle and it is the fact that warm water can reach freezing point more quickly than cold water. In his book «Metereologica» (2) Aristotle says: «Even previous warming of the water may help freezing speed. In fact warm water freezes more rapidly. Therefore many people, when they want to freeze water more quickly, expose it to the sun first. The inhabitants of Ponto, when camping on the ice for fishing (as they fish by breaking the ice), throw hot water on their fishing rods to make them freeze more quickly and use ice, as if it were lead, to make their rods more rigid».

Professor Piccardi used to say he had observed that hot water (Temperature 90° C) freezes more rapidly than cold water (Temperature 25° C) but in this case too the phenomenon is not reproducible every time because it depends on many factors which affect the warming up of water; that is: re-

lease of the gases dissolved in the water and variations in superficial evaporation. It might be supposed that those structures connecting the water molecules with hydrogen bonds undergo many different transitions and, by staying on during freezing, these transitions would modify the capacity of energy dissipation of the liquid water.

Therefore water slowly heated up to 90° C can, in favourable circumstances, freeze before less warm water, as at higher temperature there occur, at molecular level, particular energy dissipative structures which remain stable for a length of time favourable to a rapid release of heat.

Professor Piccardi was impressed by the fact that water seemed to remember the energetic entropic itinerary it had followed during warming up. He and his co-workers published a paper on the following experiment: they took a certain amount of water and divided it into two parts. One part was frozen and the other was brought to boiling-point; they were both left to go back to ambient temperature slowly. It was observed that these two amounts of water showed slight but significant differences in electric conductivity.

Giorgio Piccardi also wrote: «There are environment sensitive systems which, if modified, keep their modifications for a long time and which, if brought back to original conditions, present properties different from those they showed originally. A good example is shown by water and when we talk about water we talk about life. What I am going to say is greatly important in physical chemistry, colloidal chemistry and in both biology and medicine. Water has a three-dimensional, self-perpetuating structure capable of deformation with absorption of energy and entropy. This deformation is of a semi-perpetuating nature and lasts a long time — even a few days. When frozen, melted and brought to ambient temperature, water shows a structure which is not the same as the one presented by the same water which was evaporated, condensated and brought back to ambient tempera-

ture. These diversities due to the historical events experienced by the water last a long time and, although the traditional status variables are back to their original conditions, there is no sameness in the two types of water».

Undoubtedly water which is the most widespread substance on earth, has particular, important properties which are not all easy to explain. It has the highest solving power, higher than any other liquid and this means that it is practically impossible to get «pure» water. It has a very high specific heat, it boils at higher temperature with respect to other substances which have similar molecular structures. It is the only substance that is found, in nature, in the three phases: solid, liquid and gaseous. It is the only substance which, when solidified and ice is formed, unlike other substances, shows a characteristic increase in volume; the lesser density of ice with respect to water makes it float and consequently it protects the underlying liquid from excessive cooling. This is fundamental for the preservation and evolution of life on earth.

During his lectures Piccardi often emphasized the widely — known, exceptional characteristics of water so that no surprise should arise at other phenomena occurring in water solutions like the one he discovered and called «Activated water: this is water which acquires properties induced by means of electro-magnetic fields and retains memory of them for certain lengths of time». The phenomenon of activated water is not easy to either understand or explain.

Professor Piccardi was one of the first to investigate and lecture on surface and colloidal chemistry. What was most important to students was his teaching method based on thinking scientifically rather than on repeating things already well-known. As regards the attitude that a chemist should have towards research Piccardi used to say: «remember that it is not one N only that makes the difference between PESARE (to weigh) and PENSARE (to think)». According to Lavoisier a chemist must get used to weigh-

ing and thinking. In fact the father of modern chemistry taught chemists that in research work it is decisive to think how to organize and systemize concepts logically, to be able to understand those experiments which seem mysterious at first sight.

New ways and ideas for scientific work are even more necessary to day when chemical syntheses which cannot yet be carried out in laboratories could be planned and programmed beforehand. These new ways and ideas can also be used to understand the chemistry of life and avoid demaging its natural essence. Many phenomena in life are still mysterious to science and we have many questions to answer and many answers to find when thinking of new interpretations.

Piccardi was looking for answers from nature through his chemical and biological tests and asked himself questions which were conceptually distant from the traditional mechanist approach of science; these questions were: what cosmic, environmental signals does a seed perceive to begin germination at a particular time of year? What sort of information does a plant perceive and select to decide when it is time to come out into blossoms? It is possible to make out as early as at pre-biotic level—starting from the observation of the genesis of the various forms of crystal precipitation—which is the piece of information affecting the choice of a particular form, which choice in the evolution of the more complex biological system becomes decisive for life evolution?

A crystal reproduces itself into specific forms without a genetic programme; this may imply the action of a piece of information coming from the outside. According to Piccardi water might be the very receptor of the environmental, cosmic information which presides over life evolution on our planet. Undoubtedly investigating into the basic questions needed a methodological and epistemological change in science. Piccardi did not bother much about the epistemological interpretation, although he asked science philosophers to intervene at

critical level on the mechanist approach so as to clear the way for scientific progress by getting rid of the limitations imposed by a traditional vision. Owing to this traditional approach biological logic limits its observations on the genesis of the relationship between information and form by resorting a little too often to banal analogies such as the one of the «key and lock» which reduces the problem of molecular recognition and chemical affinity variations to simple questions of structural joint.

Piccardi acknowledged as his own the classic Galilean way of investigation which is predominantly experimental; although cautiously you can infer hypotheses from experiments.

Piccardi was convinced that scientific progress was based on experiments «provando e riprovando» (trying and trying again) rather than on interpretations and «a priori» justifications. When supported by an excessive use of analogies the assumption-based approach of science ends by re-stating previous beliefs rather than modifying them, when modifying can be necessary for scientific progress.

When writing together with Giancarlo Masini a book called «The secrets of water» (3) in memory of our professor Giorgio Piccardi and recalling our lives in the University Department of Chemistry of Firenze, we feel we have met many excellent lecturers and researchers but few of them, however able to plan and carry out traditional research work, have appeared to us as he did: a pure scientist, free from any pre-conceived thought, and capable of exploring the unknown by following his own intuitions; the way he did and loved to teach.

EXPERIMENTAL WORK

• GALILEO'S EXPERIMENT

Materials: One 2 litre plastic bottle; one 250 ml plastic bottle; two plastic stoppers stuck together for bottles, each with a central 7 mm hole; water; red wine (4).

Procedure: Fill the bigger bottle with cold water (4° C). Fill the smaller bottle with red wine. Close one of the two bottles with the two stoppers stuck together and screw in the second bottle making sure that no liquid comes out of the bottles. The bottle containing water should be put vertically on top of the smaller bottle containing wine.

If the exchange between water and wine is not immediately visible just slightly press the lower bottle of wine to let air bubbles out.

See in Figure 2 some phases of Galileo's water and wine experiment. The experiment takes about an hour.

• ARISTOTLE'S EXPERIMENT

Please read reference (5) for a correct execution of Aristotle's experiment of hot and cold water.

NOTE

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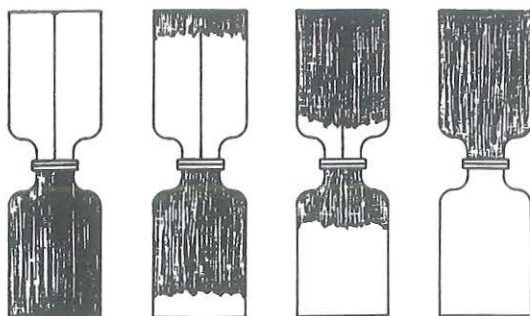


Figure 2.—Some phases of Galileo's water and Wine experiment.

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