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The Human Aspects of Chemistry and Chemical Practice:
The Life and Work of Primo Levi

Primo Levi was a chemist who has, perhaps, been more influential in the literary world than any other chemical scientist. In this brief review we recall Primo Levi's biography and explore one of his short stories in an attempt to understand how his work as a chemist influenced his writing and understanding of human life. His writings show the human dimensions of chemical practice by stressing that, while chemistry is primarily about chemical products and processes, it is human beings who are engaged in chemical practice. Primo Levi has shown that chemistry is full of the same human traits that we find in other areas of life and thought.

Biography

Primo Levi (1919-87) was born in the Turin region of Italy. Except for a few years during WW II, including nearly a year at the concentration camp Auschwitz, he primarily remained in Turin. Levi enrolled in the University of Turin in 1937 to study chemistry and graduated in 1941. Perhaps the most significant event in his life was capture by the Fascist militia while participating in the Italian resistance movement. Levi was identified as Jewish and sent to an internment camp. On February 11, 1944, he was transported to Auschwitz with 650 other inmates. He spent approximately eleven months in the camp; he was freed by the Soviet Army in January, 1945. Of the 650 inmates with whom he began his journey, only twenty survived. A main reason that Levi was one of the twenty survivors was his selection, because of his background in chemistry, to work in the synthetic-rubber factory at the camp. He was therefore able to avoid exposure to winter weather and debilitating physical labor. Chemistry saved his life.

Levi spent the first part of his post-Auschwitz career as an industrial chemist by day and a writer by night. He was the technical director of a chemical plant on the outskirts of Turin. By 1977, Levi's writing was sufficiently successful that he was able to retire from chemistry and devote himself to writing full time. Levi died in 1987, apparently a suicide, although the circumstances of his death are still under debate.

The book that first put Levi on the literary map is known in English as *Survival in Auschwitz* although a literal translation of the Italian title would be *If This Man is a Man*. Written shortly after Levi's release from Auschwitz, it was one of the first books describing the experiences of Holocaust survivors. Although many of Levi's writings focused primarily on the Holocaust, he also wrote stories on other topics, especially about work. He used many of his own work experiences as a chemist as a starting point for the chapters of a loosely biographical book, *The Periodic Table*, published in 1975. In this book, Levi presents some insights concerning the human elements of chemical practice.

An Element from The Periodic Table*: Chemistry, Writing and Human Life*

Chapter 14 of *The Periodic Table*, titled "Chromium," describes a chemical problem that Levi faced just after his return from captivity. Levi uses the problem to reflect on a number of the human aspects of chemical practice, including how incentives work within a bureaucratic structure and the persistence of out-of-date practices and language. Here is Levi's story: one day, the director of the chemical plant where Levi was employed took him to a corner of the factory's yard and showed him stacks of thousands of bright orange squares that were soft and gelatinous. They were paints that had undergone a process of "livering"; under certain conditions, paints can turn from liquid to solid and must be discarded. The paints were made with a basic chromate and an alkyd resin. The director asked Levi to determine why the problem had occurred and if it was possible to reclaim the damaged goods. Levi set right to work, first examining the resin, which had been made on-site and had an appropriate pH, and then the chromate, which had been purchased from a number of suppliers. When Levi looked at the records of the composition of the chromate, he found that each batch had exactly 29.5 percent chromium oxide. Levi, well-trained as an analytical chemist, knew that such consistent results among batches from different suppliers tested on different days should not be so similar. He set about trying to determine what had been wrong with the analytical tests that had been conducted. He first place looked at the description of the method used to determine the percent chromium oxide in each batch; one instruction he found required the analyst to add twenty three drops of a certain reagent. This triggered Levi's suspicions; a drop is an imprecise amount, and the amount of material contained in twenty three drops might vary widely. Further, based on Levi's understanding of the analytical methods he was using, twenty three drops would be enough to flood the analysis. Levi found an earlier version of the instruction card, which bore the instruction to add "2 or 3" drops and not "23." With a hypothesis in mind, Levi re-analyzed the chromate samples and found that, when using 2 or 3 drops of reagent, rather than 23, many of the chromate samples had less than the required amount of chromium oxide.

While this store may seem like a boring industrial incident, Levi's chapter on "Chromium" is about a lot more than chemistry. Levi finds in these experiences many lessons about the human elements of chemical practice. For example, he carefully considers the chemical analyst who completed test after test that gave exactly the same result but never checked to see if there could be a problem. This short-sighted attitude is related to the way that humans operate within a larger organizational structure. For example, in a large chemical company there is little incentive for an individual employee to question the instructions received from previous employees, or to challenge questionable analytical results. As long as an individual within a larger organization follows directions, there is no responsibility for the ultimate product.

From these reflections we can move to a consideration of the importance of active thought, of challenging and testing the things we inherit so as to ensure the health and validity of past traditions and practices. Levi, a survivor of the elaborate organization of Nazism and Fascism, was surely aware of the tendency of individuals to avoid the responsibility of their participation in organizations that commit grave wrongs, but also saw how those same tendencies to avoid change or responsibility were part of the everyday lives of all humans. In both research and industrial chemistry, the human aspects of the organizations in which people work and produce ideas and products can strongly influence the output. Indeed, the human aspects of the university and instructors influence the way that students learn chemistry and chemical engineering.

In the Chapter "Chromium" Levi reflects on the way that humans are conditioned by customs and previously established practices in addition to rules and conventions set by organizations and bureaucracies. Levi's solution to a paint problem was to put an additive into the paint to prevent it from congealing. However, even after the problem with the composition of the chemicals was resolved by the suppliers, the chemical operations retained the no-longer-needed additive. Levi notes that "life is full of customs whose roots can no longer be traced," and that "all languages are full of images and metaphors whose origin is being lost, together with the art from which they were drawn."

Levi fills the chapter with other examples of interest to an author, including the curious and apparently inexplicable practices that humans perpetuate without knowing why. If we pay attention to our own daily life, we can find many of these. For example, what is the reason for the "baker's dozen"? A little research shows us that the practice of providing thirteen for the price of twelve arose as a result of medieval European bread laws. Hundreds of years later we continue this practice although we no longer have regulations on the weight and price of bread; very few people are aware of the origin of this practice. While the "baker's dozen" is a *practice* whose origin is rarely known, there are also many examples of *phrases* whose origin is being lost. Consider the following phrases, and whether you know the origin: to "jump on the bandwagon," "the whole nine yards", to "learn the ropes," and to "blackmail" someone. All of these phrases are in common use, but once we learn what they mean we rarely stop to think about how they arose. Levi's observations on the persistence of practices and language apply to both the world of chemical practice and the wider world of human experience.

Within formal chemistry terminology, we can gain many interesting insights by considering words and practices whose origin may be unknown even to many chemists. Consider, for example, the names of the elements. Many of the elements on the table with high numbers have names associated with the discoverer, or an institution, state, or nation: "Curium" for Marie Curie, an important female scientist who was a pioneer in the field of radioactivity, "Berkelium" for Berkeley, California, and the University there, "Californium" after the state, and "Americium" after the Americas. The origins of these names are not hard to guess. But what about the names of some of the earlier elements, such as "hydrogen" or "argon?" What history and meaning do these names carry? Hydrogen comes from a combination of "hydro" and "gen", "hydro" referring to water and "gen" referring to genesis, or creation. Thus, hydrogen is an element that is involved in the formation of water. This provides an important clue about the early experimental history and identification of hydrogen; namely, that it was found to produce water when burned. Or consider argon; its name comes from a Greek root which means "indifferent," "inactive," or "idle." In this case we see the name of an element that is related to its chemical reactivity, or its character. Thus, even in the names of the elements, we find important clues about an element's history or chemical reactivity.

While Chapter 14 of *The Periodic Table* provides examples of the human aspects of chemical practice, the final chapter, "Carbon," provides a more philosophical reflection on the insights of chemistry and chemical practice. This chapter shows how thinking about an individual, indestructible atom can reveal the impressive processes, transformations, and continuity of the natural world. The themes of continuity and change, of beauty and complexity, of the role of humans in the natural world, and of impersonal nature and private human experience which Levi finds in his reflections on the chemistry of carbon are themes addressed in many poems, novels, and plays. For, as Levi writes, carbon is "the element of life," and therefore has a special place in the periodic table. The chapter traces a single carbon atom from its position in the crystal structure of limestone through a kiln and into the sky, through the lung of a falcon, in and out of the waters of the ocean and a mountain stream, into a grape and then wine, through a human liver, back into the air, through the eye of an insect, and finally into a glass of milk and from there into the brain of Primo Levi himself. Once this carbon atom that has traveled so far takes its place in Levi's brain, it becomes a part of the neural processes that allow him to think and write. Stop for a moment to think about the possible pathways of all the atoms that are part of your body at the moment, and realize that these atoms have been in existence for billions of years and have likely traveled around the world and been a part of other living organisms. As Levi realized, there is beauty and poetry in the pathways that even a single atom takes through time. If we were to tell the story of the pathways of individual atoms, we would be telling a story of the history of the world.

Levi's point is that the chemistry of atoms is tied up with life in very direct and profound ways, because physical and chemical processes underlie all human abilities, including our ability to think and express ourselves. Surely, this is one of the important human aspects of chemical understanding: chemistry is literally part of who we are. And the study of the chemistry of the natural world provides us a glimpse of the beautiful pathways that the constituents of our own bodies may have followed on their way to becoming part of us. In this way, a study of chemistry can help provide us with two of the most important human perspectives: humility and awe.

Bibliography

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