

Chemical Engineering Processes via Art

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Chemical Engineering deals with industrial *processes* in which raw materials and the work of chemists and physicists are transformed into commercial realities. We are usually acquainted with the sciences on which such *processes* are based, but don't pay attention to how art can serve in demonstrating these *processes*. This will be done by various paintings on the back page, noting that in many cases the artist had no intention at all of demonstrating any scientific or engineering concept in his painting; nevertheless, they are there.

The history of *processes* starts with the creation by God, 5700 years ago, of our universe, which included the sky and earth, man and woman and all the rest. However, *Radiation processes* began when God said: "Let there be lights..." (Genesis 1:14) (Figure 1). These *processes* are demonstrated here by Vincent van Gogh's (1853-1890), Dutch, one of the greatest Expressionists in modern art, in his painting "Pollard Willows and Setting Sun" (1888).

Rene Magritte (1898-1967), Belgian, one of the most important Surrealist artists and perhaps the most widely popular modernist

painter of the 20th century, "contributes" two paintings to our subject. His "Heraclitus's Bridge" (1935) is a powerful demonstration of a *Sublimation process* by which solids are transformed directly to the vapor state without passing through the liquid state (Figure 2). Here half of the bridge seems to have been sublimed, although what happened is that a patch of dense white cloud, which cover half of the bridge creates this illusionist *process*. Magritte's other painting, "The Philosophical Lamp" (1936), illuminates two absurd sights, the first a closed circle of smoke with mouth, pipe and nose constituting a single entity. The second is formed by the candle, the wax of which, while soft and already melted at its lower end, is increasingly firm towards the *burning wick*, towards the light. With respect to engineering *processes*, it may demonstrate a *cyclic process* in which a fluid undergoes several steps while flowing around the loop, where, eventually, it returns to its initial state. Power cycles, are very common examples and the most famous one is the Carnot cycle (Figure 3).

Combustion processes or *burning* are very ancient phenomena and, as a matter of fact, associated with the progress of mankind. The first *process*, according to Genesis 19:24, took place in Sodom and Gomorrah: "Then the Lord rained down *burning* sulfur on Sodom and Gomorrah

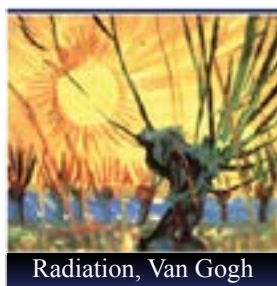


Figure 1: Radiation.

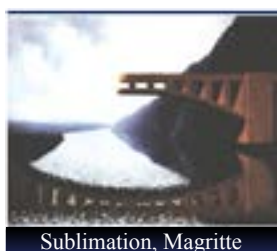


Figure 2: Sublimation Process.

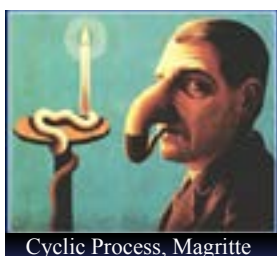


Figure 3: Cyclic Process.



Figure 4: Combustion.



Figure 5: Compression Process.

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- from the Lord out of the heavens.” It was only in 1783 that the great French chemist Antoine Lavoisier investigated the properties of oxygen and laid the foundation for modern chemistry and *combustion*. Jacek Yerka (1952), Polish, describes in a brilliant way a *Combustion process* in his painting “Eruption” (1990) which shows light *streams* flicking on and on and off and off, up and down, illuminating the houses on the mountains slopes (Figure 4).

Compression *processes* have many “faces”: the *process* of squeezing more data in a smaller storage; to limit dynamic range in music, that is, for example, to make loud parts quieter, where in Chemical Engineering it is self evident (Figure 5). Cesar Baldaccini (1921), born in Marseilles, in his status “Compression” (1970) demonstrates what happens when the components of a bicycle have been squashed into a square block.

Extraction processes may be demonstrated by Mark Rothko’s (1903-1970) painting “White and Greens in Blue” (1957) (Figure 6). He was a Russian-born U.S.A painter, one of the leading figures of Abstract Expressionism whose work consisted of large-format paintings of blurred colored rectangles. In the above painting, two *stages* in the *Extraction process* may be observed. In the upper part of the picture, above the white line in the middle, the two *phases* are completely mixed, corresponding to one color in the painting. In this



Figure 6: Phase separation Process.

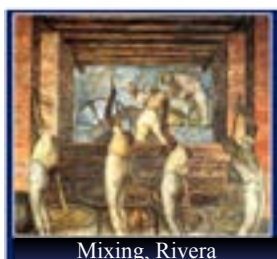


Figure 7: Mixing.



Figure 8: Diffusion.

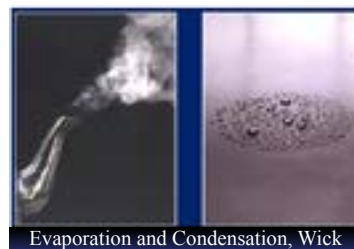


Figure 9: Evaporation & Condensation.

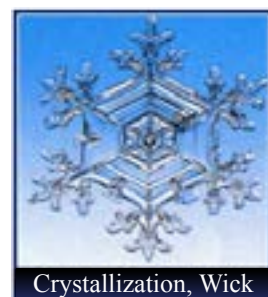


Figure 10: Crystallization.



Figure 11: Pumping process.



Figure 12: Impinging Streams.

region mass transfer takes place, namely, the *mixing* and *Extraction stage* (Figure 7). In the lower part of the picture, the *phase separation stage* is demonstrated by the two layers of the immiscible liquids having different colors (Figure 6).

Diffusion, Crystallization, Evaporation and *Condensation processes* are only part of striking color photographs by Walter Wick which appear in his astounding book [1] (Figures 8 and 9). In his *Diffusion*, a drop of blue water enters a jar of clean water, while two states out of nine are shown demonstrating the progress of the *Diffusion process* (Figure 8). *Crystallization* is demonstrated by ice crystals which grew into an astonishing six-sided design (Figure 10). His *Condensation* photograph may be looked upon also as an *Extraction process* in the

following way. The drops are created due to *mixing* of the two *phases* above and below the drops while mass transfer takes place in the region of the drops.

Pumping processes are demonstrated by Leonardo da Vinci's (1452-1519) drawing "Archimedes Screw and Pumps to Draw up Water" (c. 1480) and *Mixing processes* by Diego Rivera (1886-1957), Mexican painter of social themes who painted on murals for public buildings, in his work of art "The Sugar Mill" (1923) (Figure 11).

And finally, *Impinging-stream processes* [2] (Figure 12). Here, a unique configuration of a two-phase suspension, gas-solid, is applied for intensifying transfer *processes*. In this method, two *streams* of the suspension flowing on the same axis in opposite direction are colliding. If each *stream* contains particles of a different color, then, while colliding, particles from one *stream* penetrate into the opposite

one; eventually effective *mixing* will occur yielding as a product a homogeneous mixture of particles. "Encounter" (1944) by Maurits Cornelis Escher (1898-1972), a Dutch, the greatest graphic artist, illustrates such a *process*. According to Escher, a white optimist and a black pessimist meet each other shaking hands while walking in opposite directions one towards the other. Eventually at the back, after good *mixing* takes place, a "homogeneous solution" is obtained.

So, in conclusion, don't Chemical Engineering *Processes* look nicer via Art?

References

1. Wick W (1997) A Drop of Water. Scholastic Press, New York.
2. Tamir A, Huang B (1994) *Impinging-Stream Reactors: Fundamentals and Applications*. *Drying Technology: An International Journal* 13: 503-504.