

# Entropy and Rust

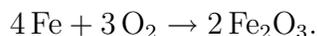
[Letter to the editor of *American Journal of Physics*.]

[Submitted 12 May 2010. Revised 14 May 2010. Accepted 17 May 2010.]

According to a common misconception, “The entropy law describes the tendency for all objects to rust, break, fall apart, wear out, and otherwise move to a less ordered state.”<sup>1</sup>

One error arises in the very first instance. Does rusting lead to increased entropy?

The rust reaction is



According to standard tables<sup>2</sup> the entropy (at room temperature 298.15 K and at pressure  $10^5$  Pa) of one mole of Fe is 27.280 J/K, of one mole of O<sub>2</sub> is 205.147 J/K, and of one mole of Fe<sub>2</sub>O<sub>3</sub> is 87.404 J/K. The entropy of the reactants is 724.561 J/K, the entropy of the products is 174.808 J/K, so the reaction results in an entropy *decrease* of 549.753 J/K.

It is easy to understand why this should be so: gases typically have much greater entropies than solids. And of course this doesn't mean that during rusting, the entropy of the universe decreases: although the entropy of the iron plus oxygen decreases, the entropy of the surroundings increases by even more. Nevertheless, it is clear that rusting itself involves a decrease in entropy, not an increase.

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<sup>1</sup> This particular quote comes from an on-line source: Cutler J. Cleveland and Robert Kaufmann  
“Fundamental principles of energy,” in *Encyclopedia of Earth*, last updated 29 August 2008

[http://www.eoearth.org/article/Fundamental\\_principles\\_of\\_energy](http://www.eoearth.org/article/Fundamental_principles_of_energy)

accessed 12 May 2010.

But the spirit of this quote can be found in many places. “Entropy tends to make our eyes grow weaker as we age ... entropy causes iron and other metals to rust” appears on page 163 of Louis M. Savary, *Teilhard de Chardin: The Divine Milieu Explained* (Paulist Press, Mahwah, NJ, 2007).

“Entropy imposes itself in the form of limitation and in the natural tendency toward confusion and chaos, toward decay and destruction. Entropy is why ice cream melts and people die. It is why cars rust and forests burn. Preponderantly, the second law describes effects that we don’t want to see” appears on page 68 of Gilbert L. Wedekind, *Spiritual Entropy* (Xulon Press, Fairfax, VA, 2003).

<sup>2</sup> Ihsan Barin, *Thermochemical Data of Pure Substances* (VCH Publishers, Weinheim, Germany, 1995) pages 675, 1239, and 702.