Director's Corner

"There is no free lunch," - we all understand that saying very well. Someone, somewhere, must pay for that lunch. This phenomenon is easy to understand and everyone accepts it without much argument. We also learn early in the chemical engineering curriculum that we cannot violate the laws of thermodynamics, no matter the circumstances. In that respect, the second law of thermodynamics states that it is impossible to convert heat energy to mechanical energy with 100 percent efficiency. After the process of heating a gas to increase its pressure to drive a piston, there is always some leftover energy in the gas that cannot do any additional work. This waste heat must be discarded by transferring it to a heat sink. For example, a car engine exhausts its spent fuel and air mixture into the atmosphere. Additionally, any device with movable parts produces friction that transfers unusable mechanical energy as heat from the system to a heat sink. This is why the U.S. Patent Office summarily rejects claims of perpetual motion machines. In a closed system, any change or activity leads to a more disordered (higher entropy) state. In other words, the entropy of the universe always increases. The best we can do is slow this increase to the limiting case in which the increase in entropy approaches, but never really reaches, zero.

So, why am I talking about thermodynamics, the second law, and entropy, and what does all this have to do with process safety? Well, translated to applications with regard to process safety issues, the analogy is both stark and appropriate. That is, every activity in the chemical processing industry involves a hazard and an associated amount of risk. Risk can be analogous to an increase in disorderliness or an increase in entropy. We have no choice most of the time with regard to accepting a hazard (once we have exhausted inherent safety discussions) because of the associated benefit it brings. For example, we use a car (knowing that it represents a hazard) because of the associated benefits. We must manage risk, but, just like entropy, we know that risk in a limiting case approaches, but never really reaches, zero. Risk for any activity plotted against the resources spent to reduce the risk represents a classic asymptotic curve that never touches the independent axis. Also, it quickly becomes apparent that, after a certain point, we reach and go beyond the point of diminishing return on investment. Some would call that point as the acceptable level of risk. Where is that point, how is it determined, and does it change with time? Those are complex and complicated questions that require significant thought and analysis to find answers.

In general, society through complicated socio-legal policy making approach determines the answers. However, various factors directly or indirectly affect those determinations (*e.g.,* affluence of the society, risk understanding, maturity of infrastructures, and many others). Once determined, the acceptable risk level does not remain constant. It changes with time, usually towards lower and lower risk tolerance. So, as we engage in our quest for risk reduction and risk management, we must remember some simple realities. Just as there is no free lunch, there is also always some risk involved in any activity.

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