What Can Irreversible Thermodynamics Do for Us?

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In 1966, James Wei, one of the Top 30 'Eminent Chemical Engineers' at the time, placed the following rhetorical question in one of his papers: "Where is irreversible thermodynamics applicable and fruitful?" [1]. He concluded that the extensive theoretical developments in irreversible thermodynamics contrast with limited applications. James Wei eventually paraphrased President Kennedy: 'Ask not what we can do for Irreversible Thermodynamics; ask what Irreversible Thermodynamics can do for us".

Today, more than 50 years later, we have many answers to Wei's question. In this presentation, we will present recent examples from joint industry projects where nonequilibrium thermodynamics has been a crucial component. We shall demonstrate how nonequilibrium thermodynamics is currently being taken advantage of to provide detailed geometry specifications for energy efficient heat exchanger designs and how it has been used to obtain beyond state-of-the art description of flow through nozzles without the need for additional fitting parameters. We will also discuss to which extent heat-mass coupling plays a role in the modelling of distillation columns and to predict moisture migration under insulation. A dive into these examples will serve to demonstrate that not only is irreversible thermodynamics useful, but it is a crucial tool in the transition to a sustainable future. Eventually we shall outline remaining challenges to overcome to make irreversible thermodynamics a more frequently used tool in industrially relevant examples.

References

[1] J. Wei, Ind Eng Chem 58(10): 55-60, 1966