Pergamon

Int. J. Heat Mass Transfer. Vol. 40, No. 8, pp. 1991, 1997

0017-9310/97 $17.00+0.00

PII: S0017-9310(96)00261-X

BOOK REVIEW

T. R. BOTT, **Fouling of Heat Exchangers.** Elsevier Science, Amsterdam, 1995, 546 pp., Dfl 415.00, US$ 244.00

Quote 'The purpose of this book, therefore, is to present a comprehensive appraisal of current knowledge in all aspects of heat exchanger fouling including fundamental science, mathematical models such as they are, and aspects of the practical approach to deal with the problem of fouling through design and operation of heat exchangers'. With 17 chapters and 546 pages one would suspect that the author would have met the purpose of the book. In part he has, but has not furthered the design of exchangers which suffer from fouling.

The introduction in Chapter 1 is brief and Chapter 2 on basic principles is very basic with equation 2.12 wrong (one negative sign should be positive) and the units in the example on resistances also in error. Whatever happened to the thermal resistance formula in cylindrical coordinates for heat transfer through tubes! There are no comments on the aspects of overdesign for clean conditions or how to control the exchanger. Additionally some comments on temperature profiles within heat exchangers would have been useful, as well as how film heat transfer coefficients depend upon the fluid velocity to some power depending upon the type of geometry and flow regime. A table of fouling resistances taken from TEMA are included.

The chapters that follow consider cost of fouling (Chapter 3), fouling models, but no data (Chapter 4), fluid flow and mass transfer (Chapter 5), which should have been in Chapter 2, and then the main thrust of the book: the types of fouling. Adhesion is discussed in Chapter 6, particulate deposition in Chapter 7, crystallisation and scale formation in Chapter 8, freezing fouling and liquid solidification in Chapter 9, corrosion fouling in Chapter 10, chemical reaction fouling in Chapter 11 and, finally, biological growth on the surfaces in Chapter 12. These chapters are a must for anyone doing research into fouling and for practitioners with particular types of fouling in their equipment.

The next chapter title wets the appetite of the heat exchanger designer and operator—'The design, installation, commissioning and operation of heat exchanger to minimise fouling'. In the previous chapters the temperature of the exchanger surface is all important, but there is no discussion on temperature profiles in heat exchangers—what a shame. There is a reasonable discussion on the effect of velocity, temperature, concentration, surface conditions and upstream conditions. There is a summary of practical design concepts, but the selection of heat exchangers is poor. Now comes an example on the choice of the value of the fouling resistance in design calculations and how this affected the operation of a PHE. A redesign of the PHE avoided the fouling problems, but the lack of details means this is of minimal use to designers. The summary of this example states that experience is paramount. What follows are two paragraphs and two figures on exchanger control—not enough. The chapter ends with a short discussion with too little detail on acceptance, commissioning and start up, and finally plant operation.

The next three chapters consider the ways to tackle fouling. The use of additives to mitigate fouling in Chapter 14 considers liquid systems (mainly aqueous) and gas systems (mainly combustion). Cleaning of heat exchangers in Chapter 15 is worth reading, expecially with respect to on-line and off-line methods of cleaning. There is a change of chapter title on p. 393—fouling of heat exchangers. Fouling assessment and mitigation in some common industrial processes: cooling water systems, combustion systems and food processing are discussed in Chapter 16. For the cooling water designs there are some recommendations to reduce fouling—velocity of 1 to 2 m s^{-1} through tubes and 1 m s^{-1} on shellside, look for worst conditions over 12 months; temperature and flow rate, outlet temperature less than 10°C and wall temperature less than 70°C. The sponge ball Taprogge system (mechanical) for cleaning of steam condenser tubes is better than chlorination (chemical) for biological fouling.

The final chapter, Chapter 17, discusses obtaining data on fouling, experience, laboratory studies and plant data. Beware of experience in using fouling resistance values, and this is illustrated by an example on p. 480. It is the same problem discussed in Chapter 13 on p. 278, with the same comments, and the Table 17.1 is only a slight rearrangement of Table 13.3. The discussion on the laboratory and plant studies details the pitfalls of different conditions—velocity, temperature, surface conditions, concentration and measurement.

Overall the book is worth reading and confirms that there is still much to be done to fully understand and combat fouling in heat exchangers.

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