ECOLE POLYTECHNIQUE DE BRUXELLES

Cooling down a coke can

Experiment study

Fluid Mechanics and Transport Processes

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"Cooling down a coke can"

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Chapitre 1

Introduction

This report outlines the physics behind an experiment produced during the MECA-H3001 “Fluid Mechanics and Transport Processes” course of the ULB (Université Libre de Bruxelles) on Friday, the sixteenth of October 2015.

The experiment can be found by following this link [1] and was described as following :

- Three coke cans were available as well as a bucket of ice and water (at 0°C) and a drill to spin the can inside the bucket.
- One of the cans was used to determine the initial temperature (16°C) of the fluid (essentially water) inside the can.
- One can was left inside the bucket for 60 seconds and a final temperature of 11.9°C was measured as a result of the conductive heat transfer with the surrounding fluid.
- One can was spun inside the bucket for 60 seconds at about 1000 rounds per minute, and a final temperature of 11°C was measured as a result of the convective and conductive heat transfer.

In the first chapter, convective and conductive processes that are related to the experiment will be described. Those phenomena will then be applied to the problem via a mathematical model, including a discussion of simplifications brought to the problem in order to simplify calculations. Lastly, a comparison between the model and reality followed by a conclusion on mathematical models will be presented.

1. `https://www.youtube.com/watch?v=MSwc_IAPh3E`

Chapitre 2

Heat transfer processes

They are three different ways of transferring heat : conduction, convection and radiation. Du to its nature, radiation can be neglected for this experiment and will thus not be presented here.

2.1 Conduction

Thermal conduction is a heat transfer process without macroscopic movement of matter. It is initiated by a difference of temperature between contiguous bodies (or inside a body). This difference of temperature implies a difference of internal energy : the energy is higher in the warmer area than in the cooler. By diffusion and collisions between the particles which can be molecules in a fluid or conduction electrons in a solid, particles in the warmer area transfer kinetic energy to the other particles, making them moving or vibrating faster. This creates a heat flow from the warmer area to the cooler until the system reaches thermal equilibrium. Also conduction is an irreversible process.

In this experiment, heat transfer by conduction is the most significant process in the first part but occurs also in the second part, in addition to convection.

2.2 Convection

Convection is a heat transfer in fluid. Convection occurs when some fluid is in movement. The movement lead to an advection(heat is transported by matters when it's moving). Then convection is decripted by :
$Convection = Conduction + advection$

Then it's easily to understand that convection is superior than conduction in fluids. In a flux situation convection is important as heat transfer mechanism.Then flow properties have a major part in heat transfers.

Chapitre 3

Mathematical model

The idea behind mathematical models is to create a simplified version of a problem, that is accurate enough to predict the behaviour of a system, but simple enough to be resolved with few calculations.

This means that some simplifications of the equations seen before can be made, using the properties of the studied system.

3.1 Simplifying assumptions

3.2 Simplified model

Chapitre 4

Comparison between reality and the mathematical model

Chapitre 5

Conclusion

Bibliographie

[1] J. Bénard, J. Bardolle, F. Bouillon, M. Cagnet *L'Oxydation des métaux.* Gauthier-Villars, 1962.