Basic Systematic Materials Selection

Homework Assignment

Created by: Kaitlin Tyler and Claes Fredriksson

Questions originally from resources created by Mike Ashby, University of Cambridge

Section 1: Translating Design Requirements

For this section, look over the design requirements for each product and translate using the selection methodology into Function, Constraints, Objectives, and Free Design Parameters.

Car Headlight Bulb Lens

A headlight is an essential part of an automobile. Headlights differ in detail, but all have a bulb containing a filament enclosed in a transparent envelope. The filament for the bulb were Tungsten but are moving towards LEDs now.

The lens, on the other-hand, protects the bulb and focuses the light where it needs to go. The lens material needs to resist abrasion from road debris. Transparent, optical quality material is a must in order for the light to shine through. Since these lenses can be damaged during accidents, a cheap and easily molded material is preferred. Cars are driven in all weather, rain or shine, so UV, fresh, and salt water resistance is needed.

Radial Turbine Blade for Aerospace Applications

In a radial turbine, the blades are rotating with high speed, where the angular velocity is a free variable. Cyclic load and strength-limited design could be considered. We want to minimize crack propagation fracture mechanisms and maximize resistance to our centrifugal loading conditions. Because of cyclic loading, there is a minimum fatigue strength at 10^7 cycles of 360 MPa. Turbines are operated at high temperatures for efficiency, so a minimum maximum service temperature of 900°C is needed.

Aircraft cargo door

The door is used to load and unload freight or luggage in an aircraft. The door can be assumed to be a panel in bending. Airplanes experience a variety of physical environments during use, so excellent resistance to UV radiation, fresh, and salt water is needed. High altitudes are quite cold, so the plane will experience temperatures anywhere from -50 to 120 °C. The body of the plane can experience loads up to 359 MPa thanks to atmospheric pressure. As always when designing parts of aircraft, minimizing mass and CO_2 footprint of the body material is critical.

Recycling containers/bins

This container has been designed to hold recycled packaging from households. The base of the recycling bin can be assumed to be a panel in bending. We need this to be cheap and easy to carry out to the curb for pickup. It will sit outside, so decent resistance to UV radiation is key to avoid discoloration. For cost purposes, the manufacturing company wishes to use injection molding to create the bins. It will hold *mostly* empty food containers, so resistance to water, food waste (10% citric acid), wine, ethanol, and vegetable oils is important.

Section 2: Applying Constraints and Objectives with Granta EduPack

For this section, take your constraints and objectives from Section 1 and apply them using Limit and Chart stages within Granta EduPack. Tutorials on how to make charts and use Limit stages can be found by clicking the links in this document or on the Ansys Learning YouTube channel. List the top 5-10 materials based on your findings.

Car headlight lens

Radial turbine blades

Aircraft cargo door

Recycling containers