FLAP ACTUATOR SYSTEM
SOLUTION

1.0 Aim: To calculate the requited input torque in the actuator system in order to overcome the resisting for on the flaps.

2.0 Notation:

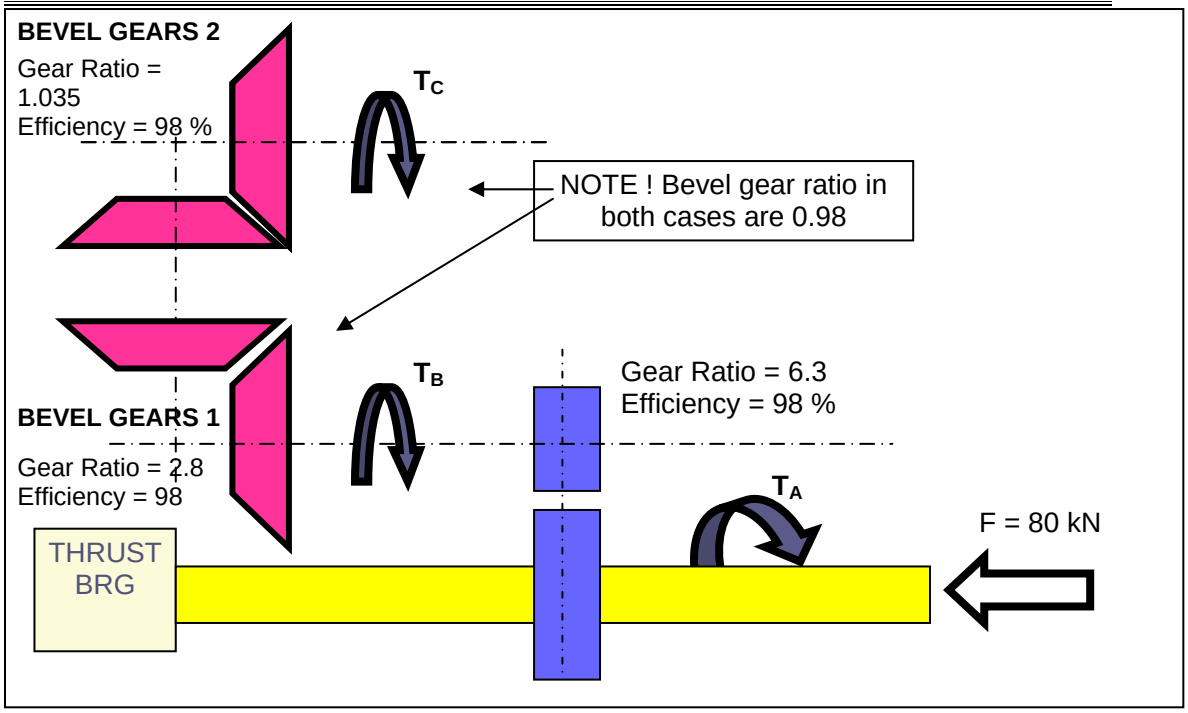
T = Torque (Nm)

η = Efficiency

3.0 Problem: Engineers at Goodrich are designing a flap actuator system for airbus A400. They have determined that in order to lower the flap angle to 20o they have to overcome a resisting force of 80 KN.

From the diagram of the control system provided calculate the input torque to do this.

- Given: 80 KN at 20^o (+ VE Compressive force)
- Pitch on lead screw on shaft ‘A’ is 13.98m
- Drag on lead screw on shaft ‘A’ at 40oC is 10 Nm (Minimum drag)
- Efficiency on lead screw on shaft ‘A’ is 90 %
- Gear ratio between shaft ‘A’ and ‘B’ is 6.3
- The losses in gears between shaft ‘A’ and ‘B’ are 98%
- The losses in bevel gears 1 and bevel gears 2 between shafts ‘A’ and ‘B’ and ‘B’ and ‘C’ respectively is 98%



4.0 Solution:

4.1 Calculate torque 'A' on ball screw.

GIVEN: Pitch on lead screw = 13.98 m

$$T_A = \frac{F \times PITCH}{2\pi}$$

$$\therefore T_A = \frac{80 \times 10^3 \times 13.98 \times 10^{-3}}{2\pi} = 177.98 Nm$$

- NOTE ! THE LEAD SCREW IS 90% EFFICIENT. BECAUSE WE ARE WORKING BACKWARDS (OUTPUT TO INPUT) WE ADD THE η (EFFICIENCY) ON I.E. DIVIDE RATHER THAN MULTIPLY.
- IF WE WERE CALCULATING THE LOSSES THROUGHOUT THYE SYSTEM (INPUT TO OUTPUT) WE WOULD CALCULATE THE LOSSES I.E. MULTIPLY

4.2 Losses on lead screw

NOTE ! OPERATIONAL TEMP RANGE FROM -40^{O}C TO 70^{O}C

GIVEN: $\eta_{\text{LEAD SCREW}}$ = 90 %

$$\frac{T_A}{\eta} = \frac{177.98}{0.9} = 197.76Nm$$

4.3 Drag on lead screw

GIVEN: DRAG @ 40^{O}C = 10Nm (Min drag = 10Nm)

$\therefore$ Min drag = 10 Nm (estimate)

$\therefore T_{A2}$ + DRAG

=176 Nm + 10Nm

T_{A2} = 207.76Nm (with drag)

4.4 Losses on the thrust bearing

GIVEN: $\eta_{\text{THRUST BEARING}}$ = 90 %

$$\frac{T_A}{\eta} = \frac{207.76}{0.9} = 230.8Nm$$

$\therefore$ Torque ‘A’ = 230 Nm

5.0 Solution:

5.1 Calculate torque on shaft, Torque B.

Gear Ratio

Ratio = 6.3

$$T_B = \frac{T_A}{6.3} = \frac{230.8}{6.3} = 36.63Nm$$

GIVEN LOSSES IN GEAR RATIO = 0.98 = 98 %

$$T_B = \frac{36.63}{0.98} = 37.39Nm(3dp)$$

$\therefore T_B$ = 37.39 Nm (3 d.p.)

5.2 Calculate torque on shaft, Torque C.

GIVEN: RATIO BEVEL $_1$ = 2.8

RATIO BEVEL $_2$ = 1.035

$\eta_{GEAR\ 1}$ = 0.98

$\eta_{GEAR\ 2}$ = 0.98

$$TorqueC = \frac{TORQUEB}{(r_{BEVEL.1} \times r_{BEVEL.2})0.98 \times 0.98}$$

$$T_C = \frac{37.39}{2.8 \times 1.035 \times 0.98^2} = 13.43$$

GIVEN: DRAG DUE TO OIL

T_C = 13.43 + 5Nm = 18.43 Nm