

Gas turbine model

Table of Contents

3.1	Introduction.....	1
3.2	System description.....	2
3.3	Starting points for the calculation.....	2
3.4	Results of the calculation.....	3

3.1 Introduction

To introduce cycles with gas mixtures into the program Cycle-Tempo a gas turbine is modelled as a third example. After this chapter a simple example of a STAG unit and a more advanced model of a district heating cycle with part load calculations are shown. The diagram of the of the gas turbine is shown in Figure 3-1.

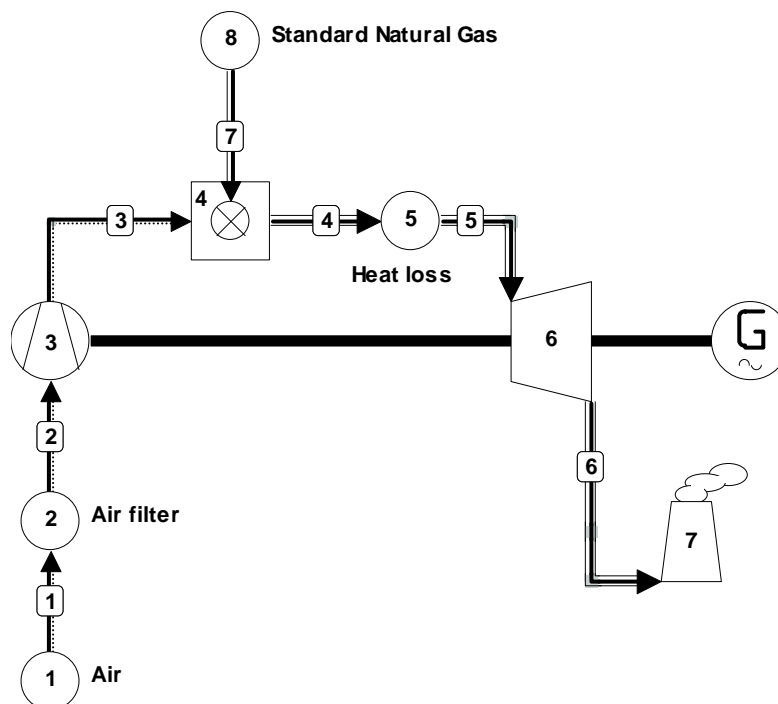


Figure 3-1: Gas turbine model



3.2 System description

Via source 1 air is fed into the system. The air is drawn-in via air filter 2 by compressor 3 and then led to combustor 4. Via source 8 the fuel, natural gas, is brought into the combustor. After the combustor the flue gases pass via sink 5, in which heat losses are taken into account, to turbine 6. In the turbine the flue gases expand to atmospheric pressure. The flue gases exit in stack 7.

3.3 Starting points for the calculation

Air supply 1

Air pressure:	POUT = 1.013 bars
air temperature:	TOUT = 15 °C
mass flow air:	DELM = -500 kg/s

Air filter 2

pressure drop:	DELP = 0.01 bar
----------------	-----------------

Compressor 3

outlet pressure:	POUT = 13.7 bars
isentropic efficiency:	ETHAI = 0.87
mechanical efficiency:	ETHAM = 0.999

Combustor 4

pressure drop:	DELP = 0.27 bar
reaction pressure:	PREACT = 13.5 bars
reaction temperature:	TREACT = 1100 °C
estimate oxidant/fuel ratio:	ESTOFR = 25
energy equation code:	EEQCOD = 1 (calculate mass flow)

Cooler 5

energy loss:	DELE = 2000 kW
estimate mass flow:	ESTMAS = 600 kg/s

Turbine 6

inlet temperature:	TIN = 1100 °C
isentropic efficiency:	ETHAI = 0.86
mechanical efficiency:	ETHAM = 0.999
no governing stage:	GDCODE = 1

Stack 7

atmospheric pressure:	PIN = 1.013 bars
-----------------------	------------------

Fuel supply 8

outlet pressure:	POUT = 15 bars
outlet temperature:	TOUT = 15 °C
heating value fuel:	LHV = 37999 kJ/kg

Generator

efficiency:	ETAGEN = 0.98
-------------	---------------

Pipe data

Pipe 1:	medium: standard air
Pipe 7:	medium: standard Slochteren natural gas

3.4 Results of the calculation

In table “Composition of fluids” the composition of the fuel (composition number 2), the air (composition number 1) and the flue gases (composition number 3) are presented. Table “Data for all pipes” contains a.o. the calculated mass flows of the fuel and the flue gases. The compressor and turbine powers can be seen in table “Energy balance”, whereas the net gas turbine power is shown in table “System efficiencies”.