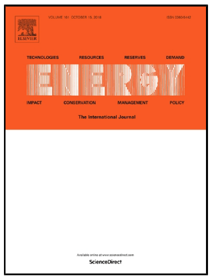
Accepted Manuscript



Use of steam jet booster as an integration strategy to operate a natural gas combined cycle with post-combustion CO_2 capture at part-load

Jorge Igor Apan-Ortiz, Eva Sanchez-Fernández, Abigail González-Díaz

PII: S0360-5442(18)31918-2

DOI: 10.1016/j.energy.2018.09.148

Reference: EGY 13842

To appear in: *Energy*

Received Date: 17 July 2018

Accepted Date: 21 September 2018

Please cite this article as: Jorge Igor Apan-Ortiz, Eva Sanchez-Fernández, Abigail González-Díaz, Use of steam jet booster as an integration strategy to operate a natural gas combined cycle with post-combustion CO_2 capture at part-load, *Energy* (2018), doi: 10.1016/j.energy.2018.09.148

Use of steam jet booster as an integration strategy to operate a natural gas combined cycle with post-combustion CO_2 capture at part-load

Jorge Igor Apan-Ortiz[a,b], Eva Sanchez-Fernández[b], Abigail González-Díaz[c*]

[a]*Universidad Nacional Autónoma de Mexico (UNAM), Ciudad de Mexico, Mexico*
[b]*Research Centre for Carbon Solutions, School of Engineering & Physical Sciences, Heriot-Watt University, EH14 4AS, Edinburgh, UK*
[c]*Instituto Nacional de Electricidad y Energias Limpias, Reforma 113, col. Palmira, Cuernavaca Morelos, Mexico. C.P. 62490.* abigail225@hotmail.com

Abstract

This paper aims to evaluate the integration of the steam jet booster in a natural gas combined cycle with CO_2 capture at low part-load operation. The steam ejector takes a high pressure motive steam flows in a supersonic nozzle while dragging a low pressure steam which comes from the crossover. Both flows mix into one at fixed pressure of 3.5 bar and sent to the reboiler. The results are compared with two integration alternatives: uncontrolled and controlled steam extraction control. Uncontrolled steam extraction provides better part-load performance than controlled. However, with sliding pressure, at 42.3% gas turbine load the low pressure steam turbine operates at 27% of its capacity compared with 66% when the energy plant operates without capture, this imposes a potential risk to the integrity of the turbine. When the steam ejector is integrated, there is no significant improvement in the efficiency compared with sliding pressure strategy. However, the used capacity of the low pressure steam turbine increases from 27% to 42.8%. Therefore, the use of the steam ejector represents a solution to avoid severe damage to the low pressure steam turbine, thus bringing more flexibility, and ensure that steam extraction will not impose any constraint to the energy plant with CO_2 capture at part-load.

Keywords: steam ejector, part-load, natural combined cycle, CO_2 capture, steam extraction, control strategy

Nomenclature

A1	Nozzle's throat cross-section area
A2	Injector's nozzle outlet cross-section area
A3	Diffuser's Throat cross-section area
DCC	Direct Contact Cooler
GHG	Greenhouse Gas
GT	Gas Turbine
HP	High Pressure
HRSG	Heat Recovery Steam Generator
IGV	Inlet Guide Vanes
IP	Intermediate Pressure
LP	Low Pressure
NGCC	Natural Gas Combined Cycle
PMV	Pressure Maintaining Valve
ST	Steam Turbine
P	Pressure
m	Mass flow rate
T	Temperature
TET	Temperature at exhaust of the turbine
TIT	Temperature at inlet of the turbine
w	Entrainment ratio
γ	Heat capacity ratio
η	Efficiency
ν	viscosity
ρ	density
Subindex	