Rotor 36

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Original model

Rotor 36 is part of a research program to study a advanced-core compressor design with a high compression ratio (20:1). It is therefore the second stage rotor of this eight stage transonic compressor. Of these eight stages, the first four have been designed and tested : rotors 35, 36, 37 and 38. For more information, here is a link to report from NASA.

- Original technical report [1]:

```
@TechReport{reid1982design,
author      = {Reid, L. and Moore, R. D.},
title       = {Performance of single-stage axial-flow transonic compressor
with rotor and stator aspect ratios of 1.63 and 1.78, respectively, and
with design pressure ratio of 1.82},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TP-1974, url~:
\url{https://ntrs.nasa.gov/citations/19820011348}, 1982}}
```

- Pictures :

Fig1. https://catalog.archives.gov/id/17467913

Fig2. https://catalog.archives.gov/id/17467884

```
@Misc{huebler1977records,
author   = {Huebler, D.},
title    = {Rotor 36 assembly and stator 36 casing half. {R}ecords of the
{N}ational {A}eronautics and {S}pace {A}dministration, 1903 - 2006.
{P}hotographs relating to agency activities, facilities and personnel, 1973 -
2013},
note     =
{\href{https://catalog.archives.gov/id/17467913}{https://catalog.archives.gov/
id/17467913}, 1977 }, % for Fig. 1
note     =
{\href{https://catalog.archives.gov/id/17467884}{https://catalog.archives.gov/
id/17467884}, 1977 }, % for Fig. 2}
```

Useful documents

- PDF of the NASA report : rotor36.pdf
- CSV file of the blade geometry : rotor36_original.csv

Geometry

The geometry of rotor 36 is described in the original NASA report by the following tables. The length are in centimeters and the angles in degrees.

(a) Rotor 36

RP	PERCENT SPAN	RADII RI	RADII RO	BLADE ANGLES KIC	BLADE ANGLES KTC	BLADE ANGLES KOC	DELTA INC	CONE ANGLE
TIP	0.	25.291	24.778	62.68	64.29	57.83	2.39	-15.305
1	5.	24.983	24.465	62.03	63.32	56.46	2.69	-14.857
2	10.	24.636	24.153	61.29	62.26	55.19	2.99	-13.420
3	15.	24.286	23.840	60.54	61.24	54.13	3.23	-11.979
4	30.	23.212	22.903	58.52	58.56	50.95	3.64	-7.659
5	50.	21.747	21.653	56.54	55.05	46.11	4.38	-2.125
6	70.	20.229	20.404	54.21	51.54	40.31	5.64	3.616
7	85.	19.020	19.467	52.48	48.18	34.05	6.65	8.615
8	90.	18.594	19.154	52.20	47.38	31.43	6.92	10.573
9	95.	18.149	18.842	52.38	47.05	28.45	7.23	12.817
HUB	100.	17.780	18.529	52.63	46.88	25.40	7.48	13.676

RP	BLADE THICKNESSES TI	BLADE THICKNESSES TM	BLADE THICKNESSES TO	AXIAL DIMENSIONS ZI	AXIAL DIMENSIONS ZMC	AXIAL DIMENSIONS ZTC	AXIAL DIMENSIONS ZO
TIP	.021	.149	.021	.470	1.727	1.705	2.345
1	.022	.157	.022	.445	1.705	1.693	2.395
2	.023	.166	.023	.415	1.681	1.673	2.442
3	.023	.175	.023	.384	1.655	1.638	2.484
4	.025	.202	.026	.288	1.605	1.506	2.585
5	.029	.239	.030	.189	1.568	1.394	2.719
6	.032	.279	.033	.103	1.507	1.292	2.862
7	.036	.311	.036	.035	1.477	1.271	2.981
8	.037	.323	.037	.019	1.463	1.223	3.021
9	.038	.335	.038	.008	1.441	1.172	3.051
HUB	.039	.346	.039	.000	1.421	1.127	3.079

Aerodynamic design

	unit	values
pressure ratio	[-]	1.82
mass flow	[kg/s]	20.2
tip speed	[m/s]	455
tip solidity	[-]	1.3
aspect ratio	[-]	1.63
number of blades	[-]	48
rotative speed	[rad/s]	1800

Material properties

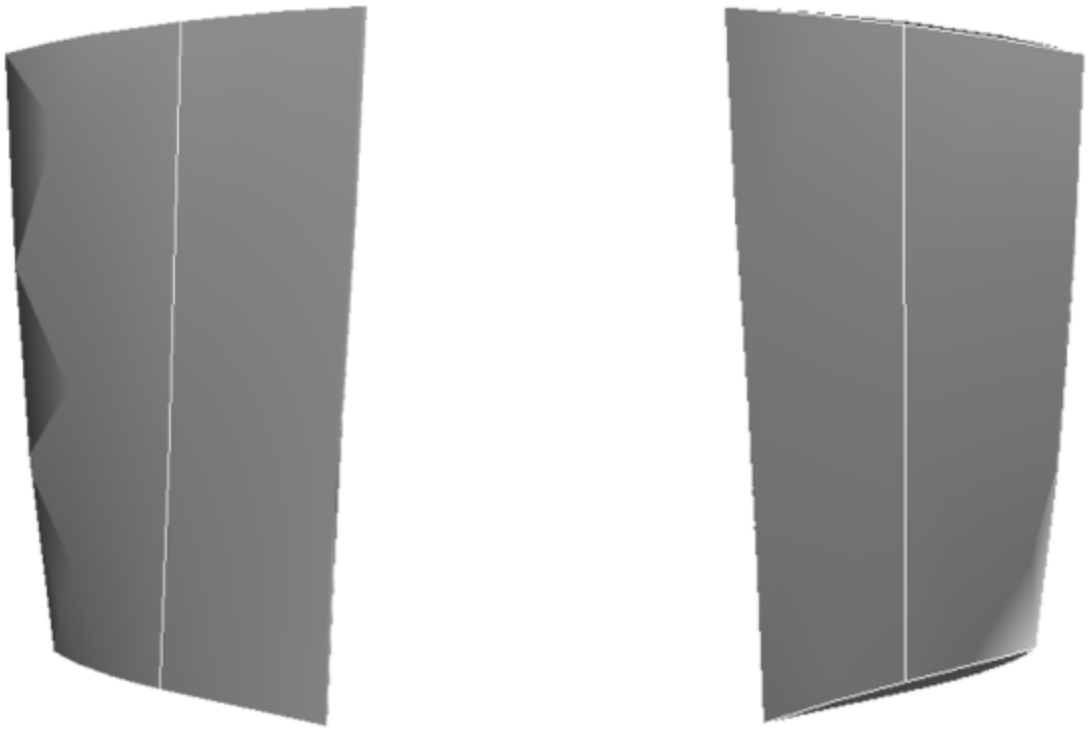
Rotor 36 is made of a 200-grade maraging steel

	unité	valeurs
alloy	[-]	18-Ni-200-maraging
Young's modulus	[GPa]	180
density	[kg/m3]	8000
Poisson's ratio	[-]	0.3
yield stress	[GPa]	1.38

First three natural frequencies (with clamped root) for the mesh:

1. (1B): 3567.3 rad/s / 567.7 Hz
2. (1T): 12971.7 rad/s / 2064.5 Hz
3. (2B): 14561.2 rad/s / 2317.5 Hz

CAD



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Modèle original

Le rotor 36 appartient à un programme de recherche visant à étudier une conception de compresseur

possédant un grand taux de compression (20:1). Il est donc le rotor du deuxième étage de ce compresseur transsonique de huit étages. Parmi ces huit étages, les quatre premiers ont été conçus et testés, ils correspondent aux rotors 35, 36, 37 et 38. Pour plus d'information, voici un lien vers rapport de la NASA.

- Rapport technique original [1]:

```
@TechReport{reid1982design,
author      = {Reid, L. and Moore, R. D.},
title       = {Performance of single-stage axial-flow transonic compressor
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id/17467884}, 1977 }, % for Fig. 2}
```

Documents utiles

- PDF du rapport de la NASA : rotor36.pdf
- Fichier CSV de la géométrie : rotor36_original.csv

Géométrie

La géométrie du rotor 36 est décrite dans le rapport d'origine de la NASA par les tableaux suivants. Les grandeurs sont en centimètres et en degrés.

(a) Rotor 36

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HUB	.039	.346	.039	.000	1.421	1.127	3.079

Caractéristiques aérodynamiques

	unités	valeurs
taux de compression	[-]	1,82
débit massique	[kg/s]	20,2
vitesse en tête	[m/s]	455
solidité en tête	[-]	1,3
allongement	[-]	1,63
nombre d'aubes	[-]	48
vitesse de rotation	[rad/s]	1800

Propriétés matériau

Le matériau du rotor 36 est un alliage à base de nickel : un acier maraging de grade 200[2], mais ses caractéristiques ne sont pas fournies dans le raport de la NASA.

Propriétés considérées : alliage 18-Ni-200-maraging

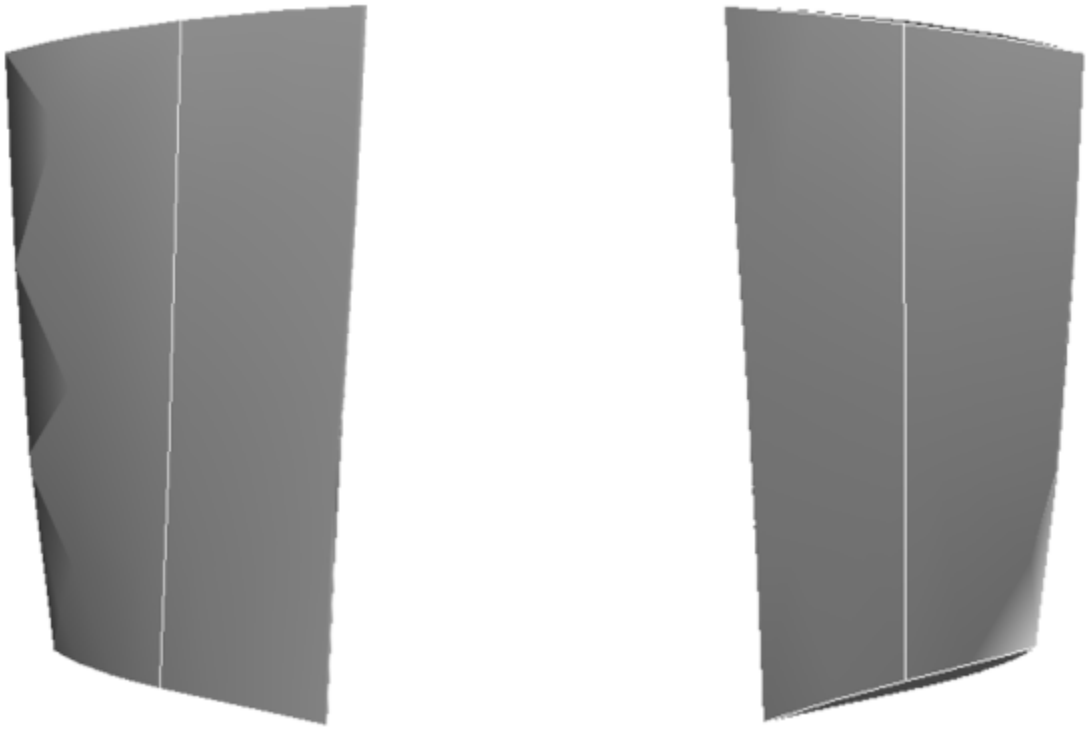
	unité	valeurs
alliage	[-]	18-Ni-200-maraging
module d'Young	[GPa]	180
masse volumique	[kg/m3]	8000
coefficient de Poisson	[-]	0,3
limite élastique	[GPa]	1,38

Fréquences des trois premiers modes (noeuds de la base encastrés) pour le maillage :

1. (1B): 3567,3 rad/s / 567,7 Hz

2. (1T): 12971,7 rad/s / 2064,5 Hz
3. (2B): 14561,2 rad/s / 2317,5 Hz

CAO



1. [a, b] Reid. «Performance of single-stage axial-flow transonic compressor with rotor and stator aspect ratios of 1.63 and 1.78, respectively, and with design pressure ratio of 1.82 » 1982. pdf
2. [a] Reid. «Design and overall performance of four highly loaded, high-speed inlet stages for and advanced high-pressure-ratio core compressor» 1978. pdf