Rotor 35

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Original model

Rotor 35 is part of a research program to study a advanced-core compressor design with a high compression ratio (20:1). It is therefore the first 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{reid1978design,
author      = {Reid, L. and Moore, R. D.},
title       = {Performance of Single-Stage Axial-Flow Transonic Compressor
With Rotor and Stator Aspect Ratios of 1.19 and 1.26, Respectively, and
With Design Pressure Ratio of 1.82},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TP-1338, url~:
\url{https://ntrs.nasa.gov/citations/19790001889}, 1978}}
```

- Picture :

Fig1. https://catalog.archives.gov/id/17466807

```
@Misc{brown1977records,
author   = {Brown, M.},
title    = {Rotor 35 - Rotor 35 - Stator 35 in casing. {R}ecords of the
{N}ational {A}eronautics and {S}pace {A}dministration, 1903 - 2006.
{P}hotographs relating to agency activities, facilities and personnel, 1977 -
2013},
note     =
{\href{https://catalog.archives.gov/id/17466807}{https://catalog.archives.gov/
id/17466807}, 1975 }, % for Fig. 1}
```

Useful documents

- PDF of the NASA report :

  rotor35.pdf
- CSV file of the blade geometry :

  rotor35_original.csv

Geometry

The geometry of rotor 35 is described in the original NASA report by the following tables. The length are in centimeters and the angles in degrees.

(a) For rotor 35

RP	PERCENT SPAN	RADII RI	RO	BLADE ANGLES KIC	KTC	KOC	DELTA INC	CONE ANGLE
TIP	0.	25.248	24.511	62.55	62.99	53.21	2.09	-15.764
1	5.	24.916	24.221	61.52	61.84	52.53	2.41	-14.327
2	10.	24.571	23.931	60.55	60.74	51.87	2.72	-12.780
3	15.	24.224	23.642	59.80	59.85	51.23	2.96	-11.326
4	30.	23.163	22.772	58.34	57.74	48.54	3.41	-7.137
5	50.	21.726	21.613	56.16	54.31	44.26	4.21	-1.890
6	70.	20.221	20.454	53.70	49.53	39.16	5.51	3.545
7	85.	19.019	19.584	52.28	47.30	33.31	6.56	8.150
8	90.	18.596	19.294	52.00	46.85	30.96	6.86	9.887
9	95.	18.158	19.005	51.82	46.50	28.36	7.18	11.763
HUB	100.	17.780	18.715	51.69	46.24	25.70	7.46	12.787

RP	BLADE THICKNESSES TI	TM	TO	AXIAL DIMENSIONS ZI	ZMC	ZTC	ZO
TIP	.025	.175	.025	.698	2.410	2.379	3.308
1	.027	.187	.027	.635	2.361	2.345	3.354
2	.028	.199	.028	.576	2.313	2.301	3.398
3	.029	.212	.029	.529	2.268	2.242	3.438
4	.032	.252	.032	.417	2.188	2.051	3.542
5	.037	.305	.038	.280	2.133	1.896	3.701
6	.042	.361	.043	.129	2.045	1.749	3.884
7	.047	.408	.047	.058	1.992	1.715	4.007
8	.048	.425	.049	.037	1.967	1.646	4.046
9	.050	.443	.050	.017	1.940	1.579	4.082
HUB	.051	.458	.051	.000	1.915	1.520	4.118

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	[-]	1.19
number of blades	[-]	36
rotative speed	[rad/s]	1800

Material properties

Rotor 35 is made of a 200-grade maraging steel[2], but the exact material properties are not provided in the NASA report.

Considered properties: 18-Ni-200-maraging steel :

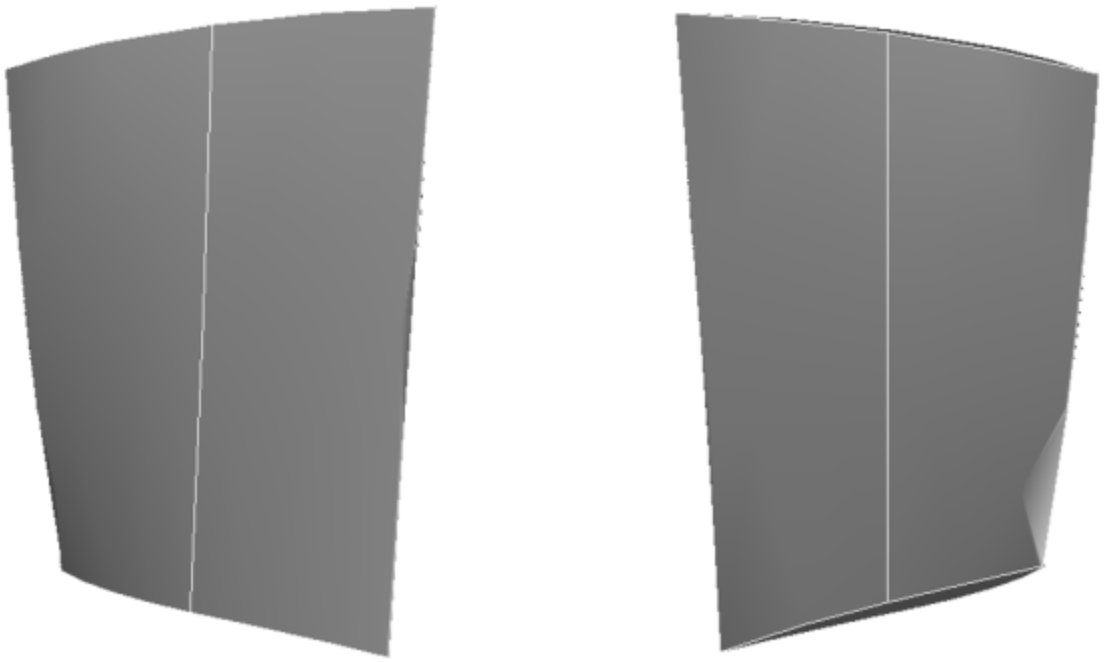
	unité	valeurs
alloy	[-]	18-Ni-200-maraging
Young's modulus	[GPa]	180
density	[kg/m3]	8000
Poisson's ratio	[-]	0.3
yield stress	[GPa]	1.38

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

1. (1B): 5009.3 rad/s / 797.2 Hz
2. (1T): 14852.9 rad/s / 2363.9 Hz

3. (2B): 18888.7 rad/s / 3006.2 Hz

CAD



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Modèle original

Le rotor 35 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 premier 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{reid1978design,
author      = {Reid, L. and Moore, R. D.},
title       = {Performance of Single-Stage Axial-Flow Transonic Compressor
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- Photographie :

Fig1. https://catalog.archives.gov/id/17466807

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id/17466807}, 1975 }, % for Fig. 1}
```

Documents utiles

- PDF du rapport de la NASA :

  rotor35.pdf
- Fichier CSV de la géométrie :

  rotor35_original.csv

Géométrie

La géométrie du rotor 35 est décrite dans le rapport d'origine de la NASA par les tableaux suivants. Les grandeurs sont en centimètres et en degrés.

(a) For rotor 35

RP	PERCENT SPAN	RADII RI	RO	BLADE ANGLES KIC	KTC	KOC	DELTA INC	CONE ANGLE
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HUB	.051	.458	.051	.000	1.915	1.520	4.118

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	[-]	1,19
nombre d'aubes	[-]	36
vitesse de rotation	[rad/s]	1800

Propriétés matériau

Le matériau du rotor 35 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

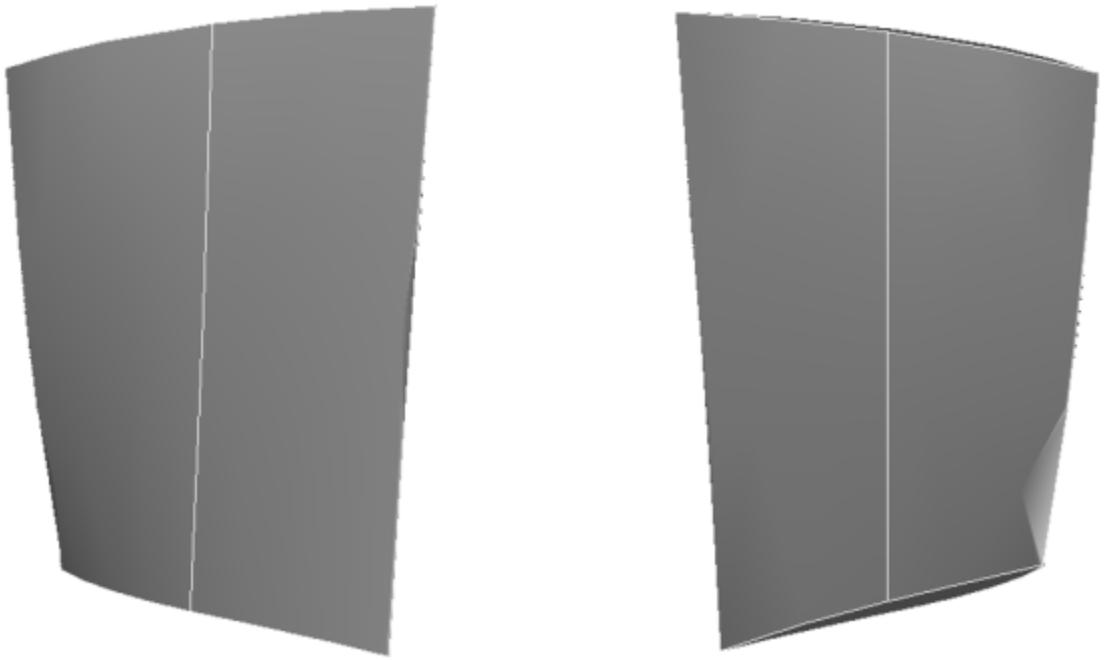
	unité	valeurs
alliage	[-]	18-Ni-200-maraging
module d'Young	[GPa]	180
masse volumique	[kg/m3]	8000
coefficient de Poisson	[-]	0,3
limite élastique	[GPa]	1,38

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

1. (1B): 5009,3 rad/s / 797,2 Hz

2. (1T): 14852,9 rad/s / 2363,9 Hz
3. (2B): 18888,7 rad/s / 3006,2 Hz

CAO



1. [a, b] Reid. «Performance of Single-Stage Axial-Flow Transonic Compressor With Rotor and Stator Aspect Ratios of 1.19 and 1.26, Respectively, and With Design Pressure Ratio of 1.82 » 1978. pdf
2. [a, b] Reid. «Design and overall performance of four highly loaded, high-speed inlet stages for and advanced high-pressure-ratio core compressor» 1978. pdf