Rotor 24A

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Original model

Rotor 24A is part of a research program to study the effects of aspect ratio, diffusion factor, and solidity on rotors. To do so, experimental studies have been conducted on a series of high-hub-tip-radius-ratio compressor stages representative of the middle and latter stages of axial-flow compressors. In fact, 14 middle stages were tested to assess the effects on performance of varying both diffusion through the rotor and stator blades and blade aspect ratio. Among these 14 stages, there are rotors 23B, 24A, 25A, 26B, 27A and 28B. Both the tip diameter and the hub-tip radius ratio were held constant throughout each stage at 50.8 centimeters and 0.8, respectively.

- Original technical report [(cite:britsch1979design>Britsch. «Design and overall performance of four highly loaded, high speed inlet stages for an advanced high-pressure-ratio core compressor » 1979. pdf)]:

```
@TechReport{britsch1979design,
author      = {Britsch, Werner R. and Osborn, Walter M. and Laessig, Mark
R.},
title       = {Effects of Diffusion Factor, Aspect Ratio, and Solidity on
Overall Performance of 14 Compressor Middle Stages},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TP-1523, url~:
\url{https://ntrs.nasa.gov/citations/19790025039}, 1979 }}
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- Picture :



https://catalog.archives.gov/id/17447846

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@Misc{huebler1976records,
author   = {Huebler, D.},
title    = {Rotor 24A. {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/17447846}{https://catalog.archives.gov/
id/17447846}, 1976 }, % for Fig. 1}
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Useful documents

- PDF of the NASA report :

  rotor24a.pdf

- CSV file of the blade geometry :

  rotor24a_original.csv

Geometry

The geometry of rotor 24A is described in the original NASA report by the following tables. The length are in centimeters and the angles in degrees.

TABLE 9. - BLADE GEOMETRY FOR ROTOR 24A

RP	PERCENT SPAN	RADII RI	RO	BLADE ANGLES KIC	KTC	KOC	DELTA INC	CONE ANGLE
TIP	0.	25.400	25.400	63.11	57.98	53.82	2.69	0.057
1	5.	25.168	25.146	62.88	57.69	53.30	2.87	-0.319
2	10.	24.911	24.892	62.62	57.32	52.71	3.07	-0.280
3	15.	24.655	24.638	62.36	56.90	52.01	3.26	-0.243
4	30.	23.886	23.876	61.56	55.59	49.74	3.84	-0.134
5	50.	22.854	22.860	60.46	53.80	46.46	4.57	0.071
6	70.	21.829	21.844	59.28	51.89	42.71	5.26	0.186
7	85.	21.055	21.082	58.36	50.31	39.34	5.76	0.314
8	90.	20.797	20.828	58.05	49.71	38.00	5.92	0.359
9	95.	20.538	20.574	57.73	49.01	36.32	6.07	0.402
HUB	100.	20.320	20.320	57.46	48.37	34.52	6.20	0.057

RP	BLADE THICKNESSES TI	TM	TO	AXIAL DIMENSIONS ZIC	ZMC	ZTC	ZOC
TIP	0.051	0.226	0.051	0.515	2.332	2.524	4.407
1	0.051	0.238	0.051	0.498	2.332	2.500	4.431
2	0.051	0.251	0.051	0.478	2.332	2.472	4.458
3	0.051	0.263	0.051	0.457	2.331	2.443	4.489
4	0.051	0.301	0.051	0.389	2.330	2.353	4.587
5	0.051	0.350	0.051	0.294	2.326	2.220	4.724
6	0.051	0.396	0.051	0.192	2.324	2.073	4.874
7	0.051	0.429	0.051	0.105	2.320	1.950	5.001
8	0.051	0.440	0.051	0.073	2.318	1.904	5.049
9	0.051	0.451	0.051	0.034	2.315	1.853	5.106
HUB	0.051	0.460	0.051	-0.000	2.312	1.808	5.166

Aerodynamic design

	unit	values
pressure ratio	[-]	1.257
mass flow	[kg/s]	9.46
tip speed	[m/s]	243.8
tip solidity	[-]	1.6
aspect ratio	[-]	0.67
number of blades	[-]	34
rotative speed	[rad/s]	960.28

Material properties

The original material of the rotor 24A is not defined in the NASA report.

Considered properties: 200-grade maraging steel :

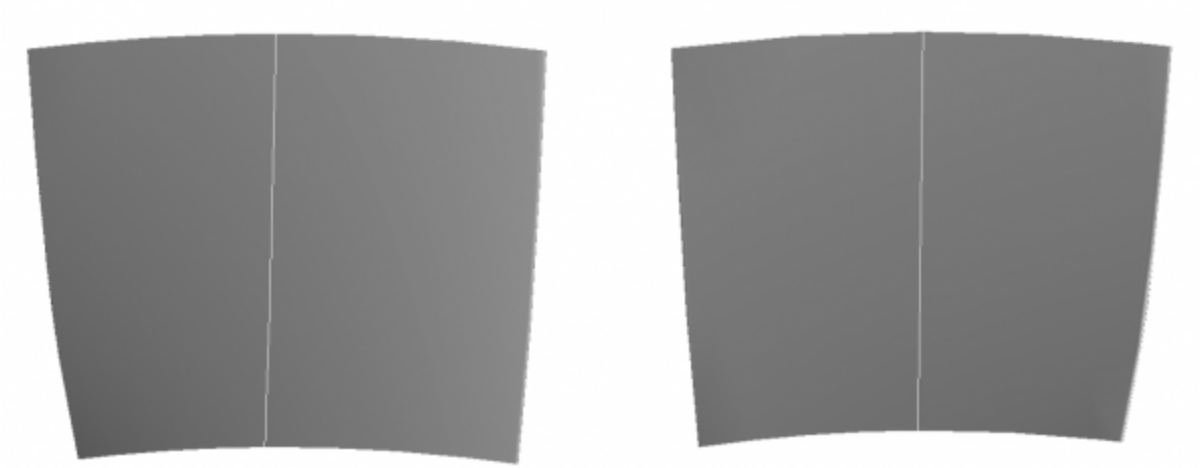
	unité	valeurs
alloy	[-]	18-Ni-200-maraging
Young's modulus	[GPa]	180
density	[kg/m3]	8000

	unité	valeurs
Poisson's ratio	[-]	0.3
yield stress	[GPa]	1.38

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

1. (1B): 8876.0 rad/s / 1412.7 Hz
2. (1T): 16341.5 rad/s / 2600.8 Hz
3. (2B): 26682.8 rad/s / 4246.7 Hz

CAD



Fichiers téléchargeables
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Modèle original

Le rotor 24A fait partie d'un programme de recherche visant à étudier les effets de l'allongement, du facteur de diffusion et de la solidité des rotors. Pour ce faire, des études expérimentales ont été menées sur une série d'étages de compresseurs à fort rapport entre les rayons du moyeu et de la tête d'aube, représentatifs des étages moyens et avancés des compresseurs à flux axial. En effet, 14 étages intermédiaires ont été testés pour évaluer les effets sur les performances de la variation de la diffusion et de l'allongement des aubes. Parmi ces 14 étages, on trouve les rotors 23B, 24A, 25A, 26B, 27A et 28B. Le diamètre de l'extrémité des aubes et le rapport entre les rayons du moyeu et de la tête d'aube ont été maintenus constants tout au long de chaque étage à 50.8 centimètres et 0.8, respectivement.

- Rapport technique original [(cite:britsch1979design>Britsch. «Design and overall performance of four highly loaded, high speed inlet stages for an advanced high-pressure-ratio core compressor » 1979. pdf)]:

```
@TechReport{britsch1979design,
author      = {Britsch, Werner R. and Osborn, Walter M. and Laessig, Mark
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- Photographie :



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note     =
{\href{https://catalog.archives.gov/id/17447846}{https://catalog.archives.gov/
id/17447846}, 1976 }, % for Fig. 1}
```

Documents utiles

- PDF du rapport de la NASA : rotor24a.pdf
- Fichier CSV de la géométrie : rotor24a_original.csv

Géométrie

La géométrie du rotor 24A est décrite dans le rapport d'origine de la NASA par les tableaux suivants. Les grandeurs sont en centimètres et en degrés.

TABLE 9. – BLADE GEOMETRY FOR ROTOR 24A

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5	50.	22.854	22.860	60.46	53.80	46.46	4.57	0.071
6	70.	21.829	21.844	59.28	51.89	42.71	5.26	0.186
7	85.	21.055	21.082	58.36	50.31	39.34	5.76	0.314
8	90.	20.797	20.828	58.05	49.71	38.00	5.92	0.359
9	95.	20.538	20.574	57.73	49.01	36.32	6.07	0.402
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RP	BLADE THICKNESSES TI	BLADE THICKNESSES TM	BLADE THICKNESSES TO	AXIAL DIMENSIONS ZIC	AXIAL DIMENSIONS ZMC	AXIAL DIMENSIONS ZTC	AXIAL DIMENSIONS ZOC
TIP	0.051	0.226	0.051	0.515	2.332	2.524	4.407
1	0.051	0.238	0.051	0.498	2.332	2.500	4.431
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4	0.051	0.301	0.051	0.389	2.330	2.353	4.587
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HUB	0.051	0.460	0.051	-0.000	2.312	1.808	5.166

Caractéristiques aérodynamiques

	unités	valeurs
taux de compression	[-]	1,257
débit massique	[kg/s]	9,46
vitesse en tête	[m/s]	243,8
solidité en tête	[-]	1,6
allongement	[-]	0,67
nombre d'aubes	[-]	34
vitesse de rotation	[rad/s]	960,28

Propriétés matériau

Le matériau original du rotor 24A n'est pas défini dans le rapport de la NASA.

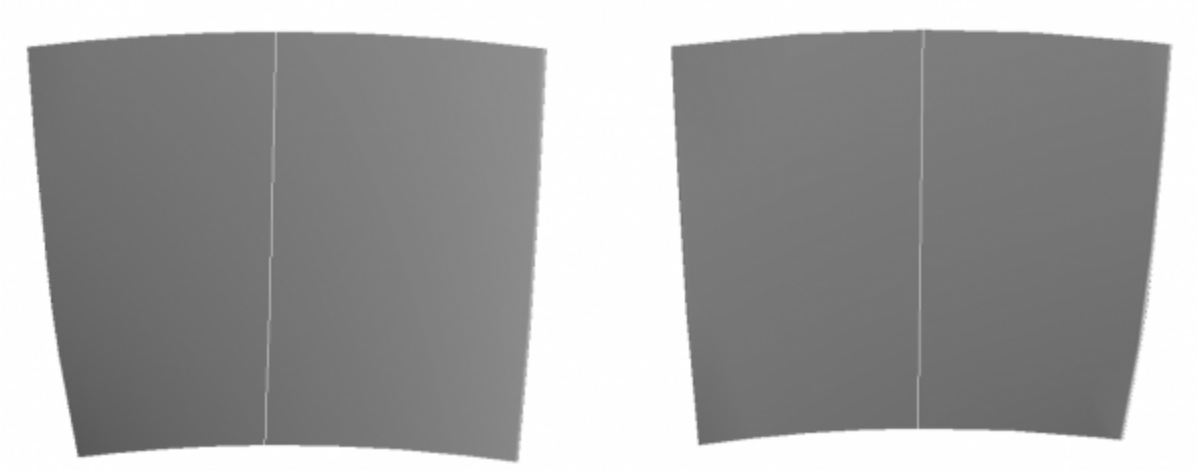
Propriétés considérées : un acier maraging de grade 200 :

	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): 8876,0 rad/s / 1412,7 Hz
2. (1T): 16341,5 rad/s / 2600,8 Hz
3. (2B): 26682,8 rad/s / 4246,7 Hz

CAO



Document issu de la page wiki:
https://wiki.lava.polymtl.ca/public/modeles/rotor_24a/accueil?rev=1663351772

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