Rotor 74A3

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Original model

Compressor 74A is part of a research program to study fans and compressors for advanced airbreathing engines to assess and improve the technology needed for high pressure ratio, good efficiency, and adequate stall margin in as few stages as possible. This compressor consists of inlet guide vanes and five stages, and it is designed for a 9.271 pressure ratio. Rotor 74A3 is the rotor of the third stage of this compressor.

- Original technical report [(cite:steinke1986design>Steinke. «Design of 9.271-Pressure-Ratio Five-Stage Core Compressor and Overall Performance for First Three Stages » 1986. pdf)]:

```
@TechReport{steinke1986design,
author      = {Steinke, Ronald J.},
title       = {Design of 9.271-Pressure-Ratio Five-Stage Core Compressor
and Overall Performance for First Three Stages},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TP-2597, url~:
\url{https://ntrs.nasa.gov/citations/19870008266}, 1986}}
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Useful documents

- PDF of the NASA report : rotor74a3.pdf
- CSV file of the blade geometry : rotor74a3_original.csv

Geometry

The geometry of rotor 74A3 is described in the original NASA report by the following tables. The length are in centimeters and the angles in degrees.

(f) Rotor 3

RP	PERCENT SPAN	RADII RI	RD	BLADE ANGLES KIC	KTC	KOC	DELTA INC	CONE ANGLE
TIP	0.	24.183	23.769	64.76	49.81	42.83	3.65	-8.673
1	5.	23.772	23.410	62.36	49.41	42.78	4.04	-7.356
2	10.	23.441	23.147	60.59	49.07	42.68	4.34	-5.847
3	20.	22.826	22.640	58.05	48.28	42.10	4.91	-3.579
4	30.	22.240	22.146	56.39	47.29	40.85	5.44	-1.744
5	40.	21.671	21.666	55.04	46.12	39.09	5.96	-.083
6	50.	21.116	21.194	53.80	44.84	37.00	6.45	1.374
7	60.	20.573	20.735	52.68	43.44	34.50	6.93	2.758
8	70.	20.042	20.290	51.67	41.95	31.57	7.39	4.100
9	80.	19.525	19.861	50.78	40.27	27.90	7.82	5.368
10	90.	19.024	19.454	50.06	38.24	22.79	8.20	6.608
11	95.	18.780	19.261	49.78	37.01	19.47	8.37	7.227
HUB	100.	18.420	18.951	49.35	35.24	14.32	8.62	7.721

RP	BLADE THICKNESSES TI	TM	TD	AXIAL DIMENSIONS ZI	ZMC	ZTC	ZO
TIP	.028	.176	.028	24.234	25.417	25.938	26.948
1	.031	.194	.031	24.170	25.418	25.883	26.975
2	.033	.208	.033	24.124	25.419	25.839	26.995
3	.038	.235	.038	24.057	25.422	25.761	27.032
4	.042	.261	.041	24.008	25.425	25.688	27.075
5	.045	.286	.046	23.964	25.428	25.615	27.126
6	.050	.310	.050	23.919	25.429	25.537	27.177
7	.053	.334	.053	23.877	25.431	25.459	27.235
8	.057	.357	.057	23.833	25.431	25.376	27.294
9	.061	.380	.061	23.784	25.427	25.285	27.359
10	.064	.403	.065	23.724	25.420	25.182	27.437
11	.066	.414	.066	23.687	25.413	25.122	27.480
HUB	.069	.430	.069	23.634	25.403	25.037	27.549

Aerodynamic design

	unit	values
pressure ratio	[-]	1.613
mass flow	[kg/s]	29.71
tip speed	[m/s]	406
tip solidity	[-]	1.21
aspect ratio	[-]	1.04
number of blades	[-]	46
rotative speed	[rad/s]	1680

Material properties

Rotor 74A3 is made of titanium according to the NASA report, but the exact properties are not provided.

Considered properties: Ti-6Al-4V, generic titanium :

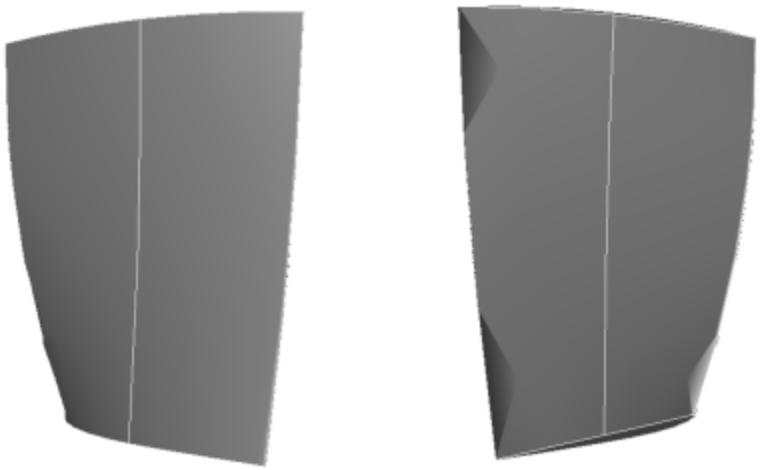
	unité	valeurs
alloy	[-]	Ti-6Al-4V
Young's modulus	[GPa]	108
density	[kg/m3]	4400
Poisson's ratio	[-]	0.34
yield stress	[GPa]	0.824

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

1. (1B): 7987.2 rad/s / 1271.2 Hz

2. (1T): 21244.6 rad/s / 3381.1 Hz
3. (2B): 30452.6 rad/s / 4846.7 Hz

CAD



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Le compresseur 74A fait partie d'un programme de recherche visant à étudier les soufflantes et les compresseurs pour les moteurs avancés afin d'évaluer et d'améliorer la technologie nécessaire pour obtenir un rapport de pression élevé, un bon rendement et une marge de décrochage adéquate avec le moins d'étages possible. Ce compresseur est composé d'aubes directrices en entrée et de cinq étages, et il est conçu pour un rapport de pression de 9,271. Le rotor 74A3 est le rotor du troisième étage de ce compresseur.

- Rapport technique original [(cite:steinke1986design>Steinke. «Design of 9.271-Pressure-Ratio Five-Stage Core Compressor and Overall Performance for First Three Stages » 1986. pdf)]:

```
@TechReport{steinke1986design,
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note        = {NASA-TP-2597, url~:
\url{https://ntrs.nasa.gov/citations/19870008266}, 1986}}
```

Documents utiles

- PDF du rapport de la NASA :

rotor74a3.pdf

- Fichier CSV de la géométrie :

rotor74a3_original.csv

Géométrie

La géométrie du rotor 74A3 est décrite dans le rapport d'origine de la NASA par les tableaux suivants. Les grandeurs sont en centimètres et en degrés.

(f) Rotor 3

RP	PERCENT SPAN	RADII RI	RADII RO	BLADE ANGLES KIC	BLADE ANGLES KTC	BLADE ANGLES KOC	DELTA INC	CONE ANGLE
TIP	0.	24.183	23.769	64.76	49.81	42.83	3.65	-8.673
1	5.	23.772	23.410	62.36	49.41	42.78	4.04	-7.356
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3	20.	22.826	22.640	58.05	48.28	42.10	4.91	-3.579
4	30.	22.240	22.146	56.39	47.29	40.85	5.44	-1.744
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6	50.	21.116	21.194	53.80	44.84	37.00	6.45	1.374
7	60.	20.573	20.735	52.68	43.44	34.50	6.93	2.758
8	70.	20.042	20.290	51.67	41.95	31.57	7.39	4.100
9	80.	19.525	19.861	50.78	40.27	27.90	7.82	5.368
10	90.	19.024	19.454	50.06	38.24	22.79	8.20	6.608
11	95.	18.780	19.261	49.78	37.01	19.47	8.37	7.227
HUB	100.	18.420	18.951	49.35	35.24	14.32	8.62	7.721

RP	BLADE THICKNESSES TI	BLADE THICKNESSES TM	BLADE THICKNESSES TO	AXIAL DIMENSIONS ZI	AXIAL DIMENSIONS ZMC	AXIAL DIMENSIONS ZTC	AXIAL DIMENSIONS ZO
TIP	.028	.176	.028	24.234	25.417	25.938	26.948
1	.031	.194	.031	24.170	25.418	25.883	26.975
2	.033	.208	.033	24.124	25.419	25.839	26.995
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6	.050	.310	.050	23.919	25.429	25.537	27.177
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11	.066	.414	.066	23.687	25.413	25.122	27.480
HUB	.069	.430	.069	23.634	25.403	25.037	27.549

Caractéristiques aérodynamiques

	unités	**valeurs**
taux de compression	[-]	1,613
débit massique	[kg/s]	29,71
vitesse en tête	[m/s]	406
solidité en tête	[-]	1,21
allongement	[-]	1,04
nombre d'aubes	[-]	46
vitesse de rotation	[rad/s]	1680

Propriétés matériau

Le matériau du rotor 74A3 est le titane d'après le rapport, mais ses caractéristiques ne sont pas fournies.

Propriétés considérées : allaige Ti-6Al-4V

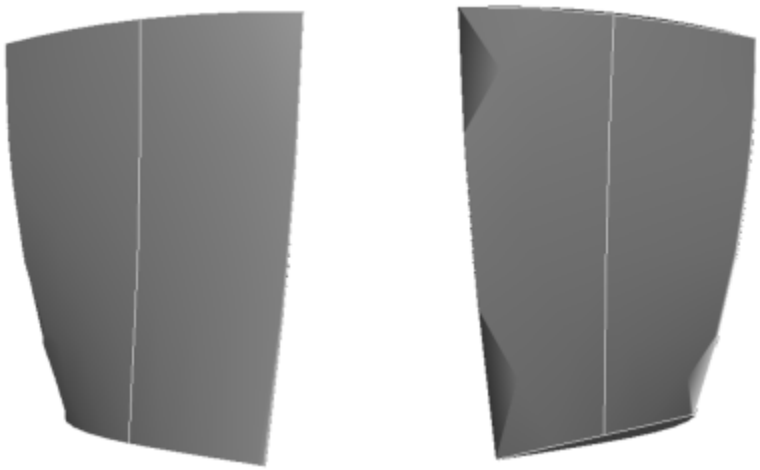
	unité	**valeurs**

	unité	valeurs
alliage	[-]	Ti-6Al-4V
module d'Young	[GPa]	108
masse volumique	[kg/m3]	4400
coefficient de Poisson	[-]	0,34
limite élastique	[GPa]	0,824

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

1. (1B): 7987,2 rad/s / 1271,2 Hz
2. (1T): 21244,6 rad/s / 3381,1 Hz
3. (2B): 30452,6 rad/s / 4846,7 Hz

CAO



Document issu de la page wiki:
https://wiki.lava.polymtl.ca/public/modeles/rotor_74a3/accueil?rev=1668794587

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