Rotor 74A1

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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 74A1 is the rotor of the first stage of this compressor.

- Original technical report [1]:

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@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}}
```

Useful documents

- PDF of the NASA report : rotor74a1.pdf
- CSV file of the blade geometry : rotor74a1_original.csv

Geometry

The geometry of rotor 74A1 is described in the original NASA report by the following tables. The length are in centimeters and the angles in degrees.

(b) Rotor 1

RP	PERCENT SPAN	RADII RI	RADII RO	BLADE ANGLES KIC	BLADE ANGLES KTC	BLADE ANGLES KOC	DELTA INC	CONE ANGLE
TIP	0.	25.613	24.973	64.13	60.20	49.27	2.97	-9.556
1	5.	25.057	24.468	62.69	58.89	48.63	3.20	-8.420
2	10.	24.444	23.963	61.22	57.51	47.85	3.44	-6.616
3	20.	23.229	22.952	58.73	54.88	45.72	3.93	-3.550
4	30.	22.008	21.941	56.48	51.41	43.25	4.41	-.800
5	40.	20.776	20.931	54.37	48.31	39.85	4.88	1.729
6	50.	19.520	19.920	52.33	45.34	35.29	5.34	4.186
7	60.	18.229	18.909	50.33	42.53	29.34	5.77	6.689
8	70.	16.889	17.899	48.33	39.61	22.00	6.13	9.324
9	80.	15.483	16.888	46.33	36.67	12.99	6.35	12.175
10	90.	13.993	15.877	44.33	33.78	1.70	6.33	15.336
11	95.	13.211	15.372	43.33	32.36	-5.09	6.19	17.060
HUB	100.	12.509	14.867	42.43	31.10	-11.85	6.06	18.117

RP	BLADE THICKNESSES TI	BLADE THICKNESSES TM	BLADE THICKNESSES TO	AXIAL DIMENSIONS ZI	AXIAL DIMENSIONS ZMC	AXIAL DIMENSIONS ZTC	AXIAL DIMENSIONS ZO
TIP	.027	.222	.027	1.877	3.610	4.170	5.679
1	.028	.239	.028	1.778	3.600	4.097	5.755
2	.030	.257	.030	1.677	3.591	4.016	5.829
3	.036	.294	.036	1.506	3.577	3.841	5.974
4	.040	.331	.041	1.326	3.564	3.625	6.137
5	.044	.368	.045	1.159	3.549	3.383	6.293
6	.048	.407	.050	.994	3.529	3.116	6.454
7	.053	.447	.055	.825	3.503	2.814	6.622
8	.059	.490	.060	.642	3.471	2.480	6.793
9	.064	.537	.066	.446	3.436	2.119	6.959
10	.070	.589	.071	.229	3.396	1.719	7.099
11	.074	.618	.074	.108	3.372	1.504	7.151
HUB	.078	.645	.077	-.000	3.350	1.311	7.204

Aerodynamic design

	unit	values
pressure ratio	[-]	1.792
mass flow	[kg/s]	29.71
tip speed	[m/s]	430
tip solidity	[-]	1.35
aspect ratio	[-]	1.45
number of blades	[-]	28
rotative speed	[rad/s]	1680

Material properties

Rotor 74A1 is made of titanium

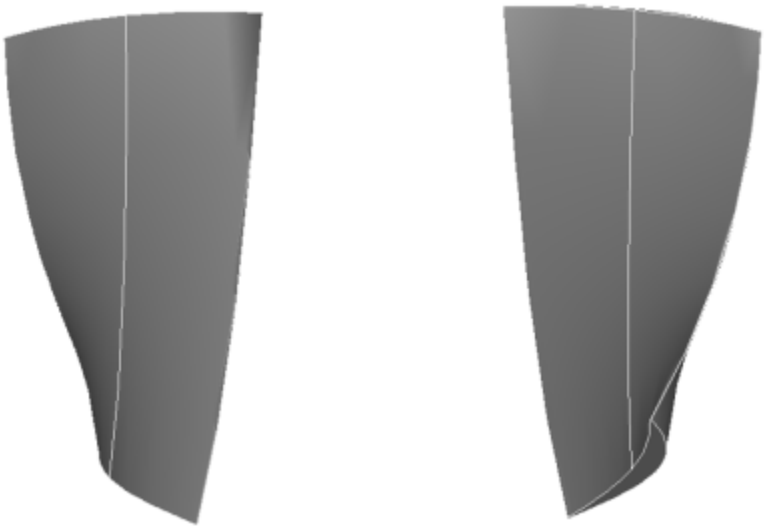
	unité	valeurs
alloy	[-]	Ti-6Al-4V
Young's modulus	[GPa]	108
density	[kg/m3]	4400
Poisson's ratio	[-]	0.34
yield stress	[GPa]	0.824

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

1. (1B): 2593.0 rad/s / 412.7 Hz
2. (1T): 8396.1 rad/s / 1336.3 Hz

3. (2B): 11696.6 rad/s / 1861.6 Hz

CAD



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Modèle original

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 74A1 est le rotor du premier étage de ce compresseur.

- Rapport technique original [1]:

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@TechReport{steinke1986design,
author      = {Steinke, Ronald J.},
title       = {Design of 9.271-Pressure-Ratio Five-Stage Core Compressor
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Documents utiles

- PDF du rapport de la NASA : rotor74a1.pdf
- Fichier CSV de la géométrie : rotor74a1_original.csv

Géométrie

La géométrie du rotor 74A1 est décrite dans le rapport d'origine de la NASA par les tableaux suivants. Les grandeurs sont en centimètres et en degrés.

(b) Rotor 1

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11	.074	.618	.074	.108	3.372	1.504	7.151
HUB	.078	.645	.077	-.000	3.350	1.311	7.204

Caractéristiques aérodynamiques

	unités	valeurs
taux de compression	[-]	1,792
débit massique	[kg/s]	29,71
vitesse en tête	[m/s]	430
solidité en tête	[-]	1,35
allongement	[-]	1,45
nombre d'aubes	[-]	28
vitesse de rotation	[rad/s]	1680

Propriétés matériau

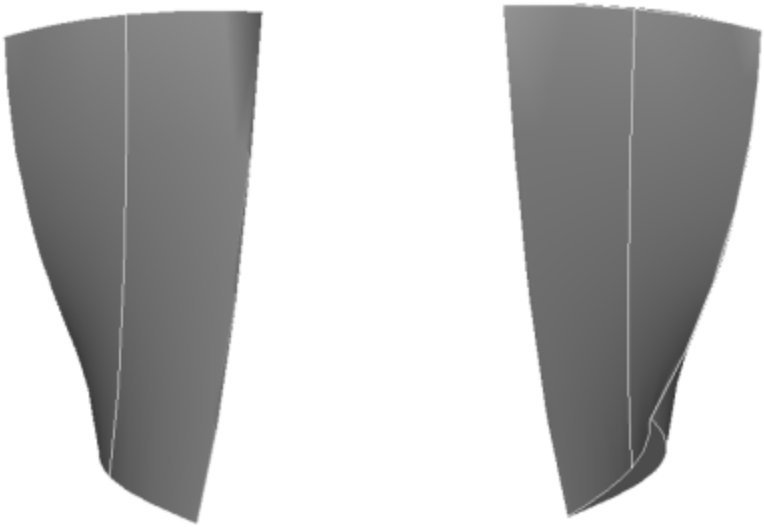
Le matériau du rotor 74A1 est le titane

	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): 2593,0 rad/s / 412,7 Hz
2. (1T): 8396,1 rad/s / 1336,3 Hz
3. (2B): 11696,6 rad/s / 1861,6 Hz

CAO



1. [a, b] Steinke. «Design of 9.271-Pressure-Ratio Five-Stage Core Compressor and Overall Performance for First Three Stages » 1986. pdf