

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]:

```
@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 | | RADII | | BLADE ANGLES | | | DELTA INC | CONE ANGLE |
|-----|---------|--------|--------|----|--------------|-------|--------|--------------|---------------|
| | SPAN | | RI | RO | KIC | KTC | KOC | | |
| 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 | -1.800 |
| 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 | | | AXIAL DIMENSIONS | | | |
|-----|-------------------|------|------|------------------|-------|-------|-------|
| | TI | TM | TO | ZI | ZMC | ZTC | 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

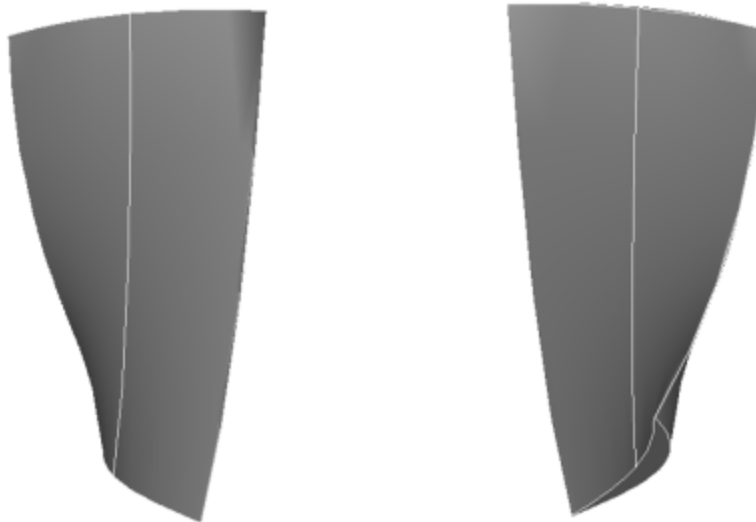
| | unité | valeurs |
|-----------------|----------------------|-----------|
| alloy | [-] | Ti-6Al-4V |
| Young's modulus | [GPa] | 108 |
| density | [kg/m ³] | 4400 |
| Poisson's ratio | [-] | 0.34 |
| yield stress | [GPa] | 0.824 |

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



Fichiers téléchargeables

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Libre accès

[lien vers le projet Git](#)

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]:

```
@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}}
```

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

| RP | PERCENT SPAN | | RADII | | BLADE ANGLES | | | DELTA INC | CONE ANGLE |
|-----|--------------|--------|--------|-------|--------------|--------|------|-----------|------------|
| | SPAN | RI | RO | KTC | KTC | KOC | | | |
| 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 | -1.800 | |
| 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 | | | AXIAL DIMENSIONS | | | |
|-----|-------------------|------|------|------------------|-------|-------|-------|
| | TI | TM | TO | ZI | ZHC | ZTC | 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 |

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

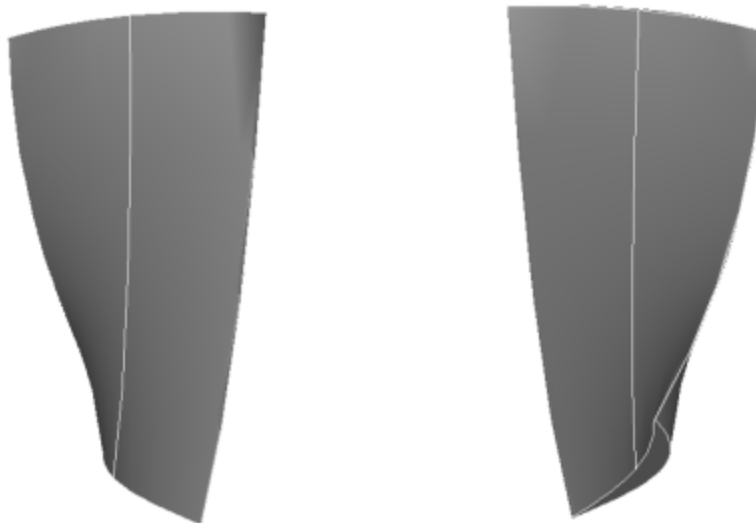
Le matériau du rotor 74A1 est le titane

| | unité | valeurs |
|-------------------------------|----------------------|-----------|
| alliage | [-] | Ti-6Al-4V |
| module d'Young | [GPa] | 108 |
| masse volumique | [kg/m ³] | 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](#)

Document issu de la page wiki:

https://wiki.lava.polymtl.ca/public/modeles/rotor_74a1/accueil?rev=1663351212

Dernière mise à jour: **2023/04/05 08:59**