

# Rotor 2

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## Original model

Rotor 2 is part of a research program to study aspect ratio because the use of high aspect ratio blading can lead to a decrease in the axial length of compressors and therefore a reduction of their size and weight. To investigate the effects of aspect ratio on compressor range and efficiency, two transonic rotors (rotor 1 and 2) were designed and tested. The variation in aspect ratio was based on a change in aerodynamic chord, and the solidity was kept the same by varying the number of blades.

- Original technical report <sup>[1]</sup>:

```
@TechReport{reid1974design,
  author      = {Reid, L. and Tysl, Edward R.},
  date        = {1974},
  institution  = {NASA Lewis Research Center Cleveland, OH, United
States},
  title       = {Performance of a transonic compressor rotor with an
aspect ratio of 6.5},
  number      = {NASA-TN D-7662},
  url         = {https://ntrs.nasa.gov/citations/19740018136},
}
```

- Picture :

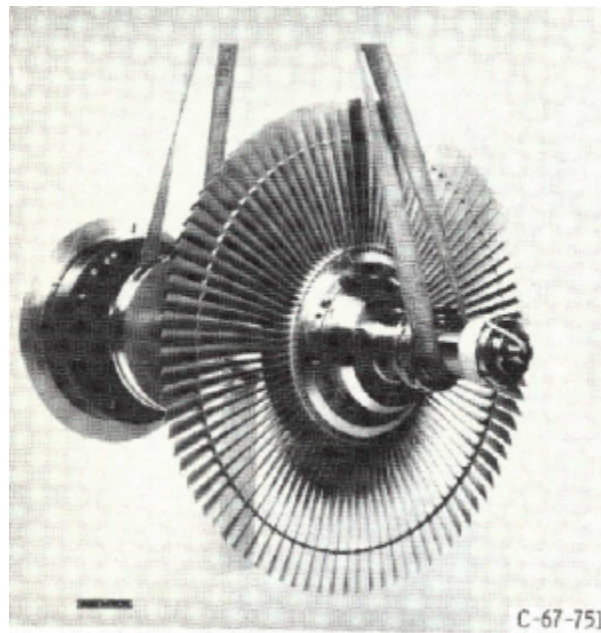


Fig1. <https://ntrs.nasa.gov/citations/19740018136> p.61

## Useful documents

- PDF of the NASA report :

rotor2.pdf

- CSV file of the blade geometry :

rotor2\_original.csv

## Geometry

[The geometry of rotor 2 is described in the original NASA report](#) by the following tables. The length are in inches and the angles in degrees.

TABLE III. - BLADE GEOMETRY FOR ROTOR 2

|     | PERCENT |        | RADI  |       | BLADE ANGLES |        |       | DELTA |
|-----|---------|--------|-------|-------|--------------|--------|-------|-------|
| RP  | SPAN    | RI     | RO    | KIC   | KTC          | KOC    | INC   |       |
| TIP | 0.      | 10.000 | 9.900 | 60.31 | 55.15        | 50.05  | 2.07  |       |
| 1   | 5.      | 9.734  | 9.647 | 58.77 | 54.04        | 49.32  | 2.10  |       |
| 2   | 10.     | 9.451  | 9.395 | 57.23 | 52.71        | 48.19  | 2.15  |       |
| 3   | 20.     | 8.880  | 8.889 | 54.39 | 49.55        | 44.70  | 2.30  |       |
| 4   | 30.     | 8.308  | 8.384 | 51.87 | 45.75        | 39.65  | 2.50  |       |
| 5   | 33.     | 8.168  | 8.258 | 51.28 | 44.73        | 38.20  | 2.54  |       |
| 6   | 35.     | 8.030  | 8.131 | 50.71 | 43.68        | 36.67  | 2.59  |       |
| 7   | 38.     | 7.892  | 8.005 | 50.15 | 42.60        | 35.06  | 2.63  |       |
| 8   | 40.     | 7.755  | 7.879 | 49.61 | 41.49        | 33.36  | 2.67  |       |
| 9   | 50.     | 7.193  | 7.373 | 47.16 | 36.38        | 25.59  | 3.00  |       |
| 10  | 60.     | 6.622  | 6.868 | 44.49 | 30.45        | 16.41  | 3.50  |       |
| 11  | 90.     | 4.708  | 5.352 | 35.36 | 10.55        | -14.26 | 7.27  |       |
| HUB | 100.    | 4.000  | 4.847 | 32.21 | 4.44         | -23.34 | 10.23 |       |

|     | BLADE THICKNESSES |       |       | AXIAL DIMENSIONS |       |       | CONE   |
|-----|-------------------|-------|-------|------------------|-------|-------|--------|
| RP  | TI                | TM    | TO    | ZMC              | ZTC   | ZOC   | ANGLE  |
| TIP | 0.020             | 0.037 | 0.020 | 0.248            | 0.248 | 0.530 | -6.411 |
| 1   | 0.020             | 0.037 | 0.020 | 0.257            | 0.257 | 0.545 | -5.531 |
| 2   | 0.020             | 0.038 | 0.020 | 0.266            | 0.266 | 0.562 | -3.612 |
| 3   | 0.020             | 0.039 | 0.020 | 0.286            | 0.286 | 0.602 | 0.599  |
| 4   | 0.020             | 0.041 | 0.020 | 0.306            | 0.306 | 0.647 | 4.884  |
| 5   | 0.020             | 0.041 | 0.020 | 0.310            | 0.310 | 0.658 | 5.733  |
| 6   | 0.020             | 0.041 | 0.020 | 0.315            | 0.315 | 0.668 | 6.522  |
| 7   | 0.020             | 0.042 | 0.020 | 0.319            | 0.319 | 0.679 | 7.252  |
| 8   | 0.020             | 0.042 | 0.020 | 0.323            | 0.323 | 0.690 | 7.923  |
| 9   | 0.020             | 0.045 | 0.020 | 0.344            | 0.344 | 0.739 | 11.459 |
| 10  | 0.020             | 0.049 | 0.020 | 0.366            | 0.366 | 0.789 | 15.435 |
| 11  | 0.020             | 0.083 | 0.020 | 0.402            | 0.402 | 0.838 | 35.893 |
| HUB | 0.020             | 0.111 | 0.020 | 0.392            | 0.392 | 0.799 | 43.582 |

## Aerodynamic design

|                | unit    | values  |
|----------------|---------|---------|
| pressure ratio | [-]     | 1.53    |
| mass flow      | [kg/s]  | 30.7    |
| tip speed      | [m/s]   | 350.8   |
| tip solidity   | [-]     | 1.3     |
| aspect ratio   | [-]     | 6.5     |
| rotative speed | [rad/s] | 1381.25 |

## Material properties

Rotor 2 is made of a 200-grade maraging steel

|                 | unité                | valeurs            |
|-----------------|----------------------|--------------------|
| alloy           | [-]                  | 18-Ni-200-maraging |
| Young's modulus | [GPa]                | 180                |
| density         | [kg/m <sup>3</sup> ] | 8000               |
| Poisson's ratio | [-]                  | 0.3                |
| yield stress    | [GPa]                | 1.38               |

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

1. (1B): 1686.8 rad/s / 268.5 Hz
2. (2B): 6385.2 rad/s / 1016.2 Hz
3. (1T): 8140.1 rad/s / 1295.5 Hz

## CAD



Fichiers téléchargeables

x

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## À propos

Le rotor 2 fait partie d'un programme de recherche visant à étudier l'allongement des aubes, car l'utilisation d'un fort allongement peut conduire à une diminution de la longueur axiale des compresseurs et donc à une réduction de leur taille et poids. Pour étudier les effets de cet allongement sur les rendements des compresseurs, deux rotors transsoniques (rotor 1 et 2) ont été conçus et testés. La variation d'allongement entre ces deux rotors a été effectuée grâce à une modification de la corde aérodynamique et la solidité a été maintenue identique en faisant varier le nombre d'aubes.

- Rapport technique original <sup>[1]</sup>:

```
@TechReport{reid1974design,  
  author      = {Reid, L. and Tysl, Edward R.},  
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- Photographie :

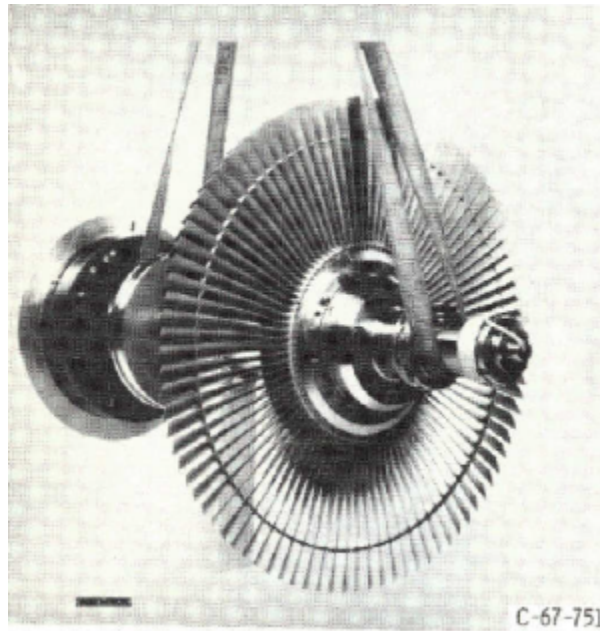


Fig1. <https://ntrs.nasa.gov/citations/19740018136> p.61

### Documents utiles

- rapport technique original  
de la NASA (.pdf)
- [fichier de paramètres géométriques](#) (.csv), utilisable en entrée de OpenMCAD<sup>[2]</sup> pour générer l'aube de référence

## Géométrie

La géométrie du rotor 2 est décrite dans le [rapport d'origine de la NASA](#) par les tableaux suivants. Les grandeurs sont en pouces et en degrés.

TABLE III. - BLADE GEOMETRY FOR ROTOR 2

| RP  | PERCENT | RADIO  |       | BLADE ANGLES |       |        | DELTA |
|-----|---------|--------|-------|--------------|-------|--------|-------|
|     | SPAN    | R1     | R0    | K1C          | K7C   | K0C    | INC   |
| TIP | 0.      | 10.000 | 9.900 | 60.31        | 55.15 | 50.05  | 2.07  |
| 1   | 5.      | 9.734  | 9.647 | 58.77        | 54.04 | 49.32  | 2.10  |
| 2   | 10.     | 9.451  | 9.395 | 57.23        | 52.71 | 48.19  | 2.15  |
| 3   | 20.     | 8.880  | 8.889 | 54.39        | 49.55 | 44.70  | 2.30  |
| 4   | 30.     | 8.308  | 8.384 | 51.87        | 45.75 | 39.65  | 2.50  |
| 5   | 35.     | 8.168  | 8.258 | 51.28        | 44.73 | 38.20  | 2.54  |
| 6   | 35.     | 8.030  | 8.131 | 50.71        | 43.68 | 36.67  | 2.59  |
| 7   | 38.     | 7.892  | 8.005 | 50.15        | 42.60 | 35.06  | 2.63  |
| 8   | 40.     | 7.755  | 7.879 | 49.61        | 41.49 | 33.36  | 2.67  |
| 9   | 50.     | 7.193  | 7.373 | 47.16        | 36.38 | 25.59  | 3.00  |
| 10  | 60.     | 6.622  | 6.868 | 44.49        | 30.45 | 16.41  | 3.50  |
| 11  | 90.     | 4.708  | 5.352 | 35.36        | 10.55 | -14.26 | 7.27  |
| HUB | 100.    | 4.000  | 4.847 | 32.21        | 4.44  | -23.34 | 10.23 |

| RP  | BLADE THICKNESSES |       |       | AXIAL DIMENSIONS |       |       | CONC   |
|-----|-------------------|-------|-------|------------------|-------|-------|--------|
|     | T1                | TM    | TO    | ZMC              | Z7C   | Z0C   | ANGLE  |
| TIP | 0.020             | 0.037 | 0.020 | 0.248            | 0.248 | 0.530 | -6.411 |
| 1   | 0.020             | 0.037 | 0.020 | 0.257            | 0.257 | 0.545 | -5.531 |
| 2   | 0.020             | 0.038 | 0.020 | 0.266            | 0.266 | 0.562 | -3.612 |
| 3   | 0.020             | 0.039 | 0.020 | 0.286            | 0.286 | 0.602 | 0.599  |
| 4   | 0.020             | 0.041 | 0.020 | 0.306            | 0.306 | 0.647 | 4.884  |
| 5   | 0.020             | 0.041 | 0.020 | 0.310            | 0.310 | 0.658 | 5.733  |
| 6   | 0.020             | 0.041 | 0.020 | 0.315            | 0.315 | 0.668 | 6.522  |
| 7   | 0.020             | 0.042 | 0.020 | 0.319            | 0.319 | 0.679 | 7.252  |
| 8   | 0.020             | 0.042 | 0.020 | 0.323            | 0.323 | 0.690 | 7.923  |
| 9   | 0.020             | 0.045 | 0.020 | 0.344            | 0.344 | 0.739 | 11.459 |
| 10  | 0.020             | 0.049 | 0.020 | 0.366            | 0.366 | 0.789 | 15.435 |
| 11  | 0.020             | 0.083 | 0.020 | 0.402            | 0.402 | 0.838 | 35.893 |
| HUB | 0.020             | 0.111 | 0.020 | 0.392            | 0.392 | 0.799 | 43.582 |

## Caractéristiques aérodynamiques

|                     | unités  | valeurs |
|---------------------|---------|---------|
| taux de compression | [-]     | 1,53    |
| débit massique      | [kg/s]  | 30,7    |
| vitesse en tête     | [m/s]   | 350,8   |
| solidité en tête    | [-]     | 1,3     |
| allongement         | [-]     | 6.5     |
| vitesse de rotation | [rad/s] | 1381,25 |

## Propriétés matériau

Le matériau du rotor 2 est un alliage à base de nickel : 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                |

|                         | unité | valeurs |
|-------------------------|-------|---------|
| <b>limite élastique</b> | [GPa] | 1,38    |

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

1. (1B): 1686,8 rad/s / 268,5 Hz
2. (2B): 6385,2 rad/s / 1016,2 Hz
3. (1T): 8140,1 rad/s / 1295,5 Hz

## CAO



</tabs>

1. <sup>a, b</sup> Reid. «Performance of a transonic compressor rotor with an aspect ratio of 6.5 » 1974. [pdf](#)
2. <sup>a</sup> Kojtych S., Batailly A. «OpenMCAD, an open blade generator: from Multiple-Circular-Arc profiles to Computer-Aided Design model» 2022. [code en libre accès](#)

Document issu de la page wiki:

[https://lava-wiki.meca.polymtl.ca/public/modeles/rotor\\_02/accueil?rev=1677698260](https://lava-wiki.meca.polymtl.ca/public/modeles/rotor_02/accueil?rev=1677698260)

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