Mathematics of Flight

Atmospheric Pressure

Atmospheric Pressure

The early flights of the Wright brothers were typically 10 to 12 feet above the ground. By 1908, their flying machine reached an altitude of 100 feet. Today's commercial jets fly at 30,000 to 40,000 feet. At such high altitudes, the atmospheric pressure is much different.

Atmospheric Pressure

Flight personnel calculate the atmospheric pressure, ***p***, using this formula:

$$p = \frac{-9.05 \left[\left(\alpha / 1000 \right)^2 - 65\alpha / 1000 \right]}{(\alpha/1000)^2 + 40 \quad (\alpha/1000)}$$

where α is the altitude of the plane, given in feet.

Thomas-Morse S4B Scout

The Thomas-Morse Scout became the favorite single-seat training airplane for U.S. pilots during World War I. The Scout first appeared with an order for 100 S4Bs in the summer of 1917. The U.S. Army Air Service later purchased nearly 500 of a slightly modified version, the S4C. Dubbed the "Tommy" by its pilots, the plane had a long and varied career.

Tommies flew at practically every pursuit flying school in the United States during 1918. After the war ended, the Air Service sold them as surplus to civilian flying schools, sportsman pilots and ex-Army fliers. Some were still being used in the mid-1930s for WWI aviation movies filmed in Hollywood.

Atmospheric Pressure

Calculate the atmospheric pressure for a Thomas-Morse S4C Scout airplane from World War I flying at 6,000 feet.

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Calculate the atmospheric pressure for a Thomas-Morse S4C Scout airplane from World War I flying at 6,000 feet.

$$p = \frac{-9.05 \left[\left(\alpha / 1000 \right)^2 - 65\alpha / 1000 \right]}{(\alpha/1000)^2 + 40 \quad (\alpha/1000)}$$

$$p = \frac{-9.05 \left[\left(6000 / 1000 \right)^2 - 65(6000) / 1000 \right]}{(6000/1000)^2 + 40 \quad (6000/1000)}$$

Atmospheric Pressure

Calculate the atmospheric pressure for a Thomas-Morse S4C Scout airplane from World War I flying at 6,000 feet.

$$p = \frac{-9.05 \left[\left(\alpha / 1000 \right)^2 - 65\alpha / 1000 \right]}{(\alpha/1000)^2 + 40 \ (\alpha/1000)}$$

$$p = \frac{-9.05 \left[\left(6000 / 1000 \right)^2 - 65(6000) / 1000 \right]}{(6000/1000)^2 + 40 \ (6000/1000)}$$

$$p = \frac{-9.05 \left[(6)^2 - 65(6) \right]}{(6)^2 + 40 \ (6)}$$

Atmospheric Pressure

$$p = \frac{-9.05\,[\,36 - 390]}{36 + 240}$$

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Atmospheric Pressure

$$p = \frac{-9.05\,[\,36 - 390\,]}{36 + 240}$$

$$p = \frac{-9.05\,[\,-354\,]}{276}$$

$$p = \frac{3{,}203.7}{276}$$

$$p = 11.61$$

The atmospheric pressure is 11.61 pounds per square inch (11.61 lb/in^2).

Boeing B-17G Flying Fortress

The Flying Fortress is one of the most famous airplanes ever built. The B-17 prototype first flew on July 28, 1935. Although few B-17s were in service on Dec. 7, 1941, production quickly accelerated after the U.S. entry into World War II. The aircraft served in every combat zone, but it is best known for the daylight strategic bombing of German industrial targets. Production ended in May 1945 and totaled 12,726.

Atmospheric Pressure

Calculate the atmospheric pressure for a B-17 Flying Fortress flying a mission at 30,000 feet during World War II.

$$p = \frac{-9.05 \left[\left(\alpha / 1000 \right)^2 - 65\alpha / 1000 \right]}{(\alpha/1000)^2 + 40 (\alpha/1000)}$$

$$p = \frac{-9.05 \left[\left(30{,}000 / 1000 \right)^2 - 65(30{,}000) / 1000 \right]}{(30{,}000/1000)^2 + 40 (30{,}000/1000)}$$

$$p = \frac{-9.05 \left[(30)^2 - 65(30) \right]}{(30)^2 + 40 (30)}$$

Atmospheric Pressure

$$p = \frac{-9.05\,[\,900 - 1950\,]}{900 + 1{,}200}$$

$$p = \frac{-9.05\,[\,-1{,}050\,]}{2{,}100}$$

$$p = \frac{9{,}502.5}{2{,}100}$$

$$p = 4.53$$

The atmospheric pressure is 4.53 pounds per square inch (4.53 lb/in^2).

North American F-86A Sabre

The F-86, the U.S. Air Force's first swept-wing jet fighter, made its initial flight in October 1947. The first production model flew in May 1948, and four months later, an F-86A set a new world speed record of 670.9 mph.

More than 5,500 F-86 day fighters were built in the U.S. and Canada. Air forces of 20 other nations, including West Germany, Japan, Spain, Great Britain and Australia, also operated the Sabre.

Atmospheric Pressure

Calculate the atmospheric pressure for a F-86D Sabre flying a mission at 42,200 feet during the Korean War.

$$p = \frac{-9.05 \left[\left(\alpha / 1000 \right)^2 - 65\alpha / 1000 \right]}{(\alpha/1000)^2 + 40 (\alpha/1000)}$$

Atmospheric Pressure

Calculate the atmospheric pressure for a F-86D Sabre flying a mission at 42,200 feet during the Korean War.

$$p = \frac{-9.05 \left[\left(\alpha / 1000 \right)^2 - 65\alpha / 1000 \right]}{(\alpha/1000)^2 + 40 \quad (\alpha/1000)}$$

$$p = \frac{-9.05 \left[\left(42{,}200 / 1000 \right)^2 - 65(42{,}200) / 1000 \right]}{(42{,}200/1000)^2 + 40 \quad (42{,}000/1000)}$$

Atmospheric Pressure

Calculate the atmospheric pressure for a F-86D Sabre flying a mission at 42,200 feet during the Korean War.

$$p = \frac{-9.05 \left[\left(\alpha / 1000 \right)^2 - 65\alpha / 1000 \right]}{(\alpha/1000)^2 + 40 \ (\alpha/1000)}$$

$$p = \frac{-9.05 \left[\left(42{,}200 / 1000 \right)^2 - 65(42{,}200) / 1000 \right]}{(42{,}200/1000)^2 + 40 \ (42{,}000/1000)}$$

$$p = \frac{-9.05 \left[(42.2)^2 - 65(42.2) \right]}{(42.2)^2 + 40 \ (42.2)}$$

Atmospheric Pressure

$$p = \frac{-9.05\,[1{,}780.84 - 2{,}743]}{1{,}780.84 + 1{,}688}$$

Atmospheric Pressure

$$p = \frac{-9.05\,[1{,}780.84 - 2{,}743]}{1{,}780.84 + 1{,}688}$$

$$p = \frac{-9.05\,[-962.16]}{3{,}468.84}$$

Atmospheric Pressure

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$$p = \frac{8707.55}{3{,}468.84}$$

Atmospheric Pressure

$$p = \frac{-9.05\,[1{,}780.84 - 2{,}743]}{1{,}780.84 + 1{,}688}$$

$$p = \frac{-9.05\,[-962.16]}{3{,}468.84}$$

$$p = \frac{8707.55}{3{,}468.84}$$

$$p = 2.51$$

The atmospheric pressure is 2.51 pounds per square inch (2.51 lb/in^2).

More Resources

Additional Resources
are available online at
www.nationalmuseum.af.mil/education/teacher/index.asp