

China's Scramjet Claim Puzzles U.S. Hypersonic Researchers

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China's success in flying a scramjet-powered hypersonic aircraft, trailing the U.S. by no more than a few years, reveals that its engineers have overcome severe cooling problems first mentioned five years ago. The successful test, announced in October, followed the January 2014 flight of a Chinese hypersonic glider.

The China Society of Aeronautics and Astronautics says the engine of the aircraft, which must have been unmanned and probably quite small, is the world's first kerosene-burning scramjet with regenerative cooling. This is at odds with the Boeing X-51A WaveRider, in which fuel cooled the engine while being heated to improve combustion, flown in the U.S in 2010 and again in 2013.

The society announced the Chinese success to recognize the achievements of the project leader, Wang Zhenguo. A professor at the National University of Defense Technology, Wang led the research and development team for more than 20 years, from concept to planning and system integration. This involved "development and production in a nationally important project for a certain type of hypersonic aircraft," the society says. Wang, referred to as the chief designer, was also in charge of flight testing.

As a result, China has become only the second country, behind the U.S., to independently fly such an aircraft, the society says. Chinese media quoted the society as making these statements in a report on its award to Wang.

On its website, csaa.org.cn, the society says Wang has undertaken pioneering research on scramjets and their ground and flight testing, achieving a leap in technology. Among his responsibilities has been an unnamed "large and important national project"—which sounds like a priority weapon system.

The date of the Chinese test is not disclosed, except that it came after the X-51A's fourth and final, fully successful flight in May 2013. The first flight of the U.S. scramjet-powered experimental aircraft in May 2010 was successful, but shorter than planned. Two failures followed.

China revealed details of ongoing studies of regeneratively cooled scramjets in 2010 but acknowledged problems with uneven temperature and heat-flux distribution that were severe enough to cause local plasticity in the flow-path structure. This early work, undertaken at the China Aerodynamics Research and Development Center in Mianyang and at Northwestern Polytechnical University in Xian, openly recognized the earlier scramjet developments made by Pratt & Whitney Rocketdyne (now part of Aerojet Rocketdyne).

At that time, Pratt & Whitney was developing the SJX61-2 scramjet, cooled by its JP7 fuel, to power the X-51A, a missile-size demonstrator built by Boeing for the U.S. Air Force. The

vehicle achieved sustained flight above Mach 5 on its final test in 2013 and proved the practical viability of an air-breathing, scramjet-powered hypersonic vehicle.



Boeing's X-51A was powered by a fuel-cooled, kerosene-fueled scramjet. Credit: U.S. Air Force

Although no follow-on demonstrators were funded, developers hoped to investigate future propulsion systems fueled by RP-1, RP-2 or JP-10. Denser than JP-7, JP-10 is a special high-flash-point fuel originally used by the Lockheed SR-71. In all cases, the key issue was the fuel's endothermic, or heat-absorbing, capability. All these fuels are essentially kerosene, with additives.

The final X-51A flight ended after 210 sec. under scramjet power when its fuel was exhausted. It proved JP-7 could successfully cool the engine and in doing so be preheated to an optimum temperature for combustion. Such recycling of extracted heat is regenerative cooling.

The Chinese claim to have successfully tested the first kerosene-burning scramjet with regenerative cooling is therefore puzzling to senior propulsion specialists who were involved in the X-51A project. Some speculate the Chinese could be making a distinction between JP-7 and standard kerosene, or possibly between a scramjet and a dual-mode propulsion system. The X-51A was first accelerated to hypersonic speeds by a rocket booster after air launch from a B-52, then flew under the power of its scramjet engine.

On Jan. 9, 2014, China tested a hypersonic glider the Pentagon dubbed WU-14. Launched by an intercontinental ballistic missile, it was presumably a demonstrator or prototype for an unpowered warhead that would exploit lift to extend range and confound defenses with maneuvers. Conceivably, the WU-14 could have been used to test the flight control system for the powered hypersonic aircraft that has now been flown.