Mustafa Demir – aerostats and drone airships

Peter Lobner, 10 March 2022

In 2021, I was pleased to receive information about aerostat and drone airship development work being conducted in Istanbul, Turkey by Mustafa Demir. Over the past five years, Demir has been developing the envelope technology and experience needed to domestically produce aerostats and airships in Turkey. His work has been supported by two technical organizations (“technoparks”) and has been recognized for its scientific innovation and research & development (R&D) value.

Demir’s recent work has been conducted in the following three stages:

- Develop and produce low-leakage envelope material and test it on a tethered aerostat
- Develop and operate a mini-airship drone
- Demonstrate mini-airship drone materials and operation at high altitude

Building on the technologies and experience from these initial development stages, Demir plans to develop much larger airships for carrying passengers on journeys that could last months. One of Demir’s long-range goals is to produce the first manned airship to make a world tour without landing and without helium and fuel replenishment during the journey.

Following is a synopsis of the three stages of development that Demir has accomplished thru 2021.

I greatly appreciate Mustafa Demir’s thoughtful input for this article.

Stage 1: Develop and produce low-leakage envelope material and test it on a tethered aerostat

Demir reported that international manufacturers like RavenAerostar and LLC Dover didn't want to sell their materials for manufacturing helium lifting gas envelopes for aerostats and airships. Therefore, he decided to develop a domestic capability for manufacturing low-leakage material for lifting gas envelopes for use in his planned aerostats and airships.

At the start, Demir decided not to use polyurethane / polyester materials, which are commonly used by other manufacturers. His Stage 1 program focused on developing a suitable low-leakage, high-quality material as well as the manufacturing processes for assembling this material into low-leakage lifting gas envelopes.

In Stage 1, Demir produced envelope materials for about 100 small aerostat prototypes with lengths from 2 to 13 meters (6.6 to 42.7 ft). This experimental program, which took five years and required 6,000 hours of production work, led to the development of a suitable low-leakage material. Demir also determined that, "Even if the perfect material is in hand, perfect production in micron scale is a must."

Success was demonstrated with a small superpressure aerostat that stayed in the air for 1 year and 10 days with only 10% gas loss. His aerostats flew at 200 meters (656 ft) above sea level (ASL). They also flew at an altitude of 250 meters (820 ft) above ground level (AGL) in Eskişehir / İnönü city, where ground level is 840 meters (2,756 ft) ASL.

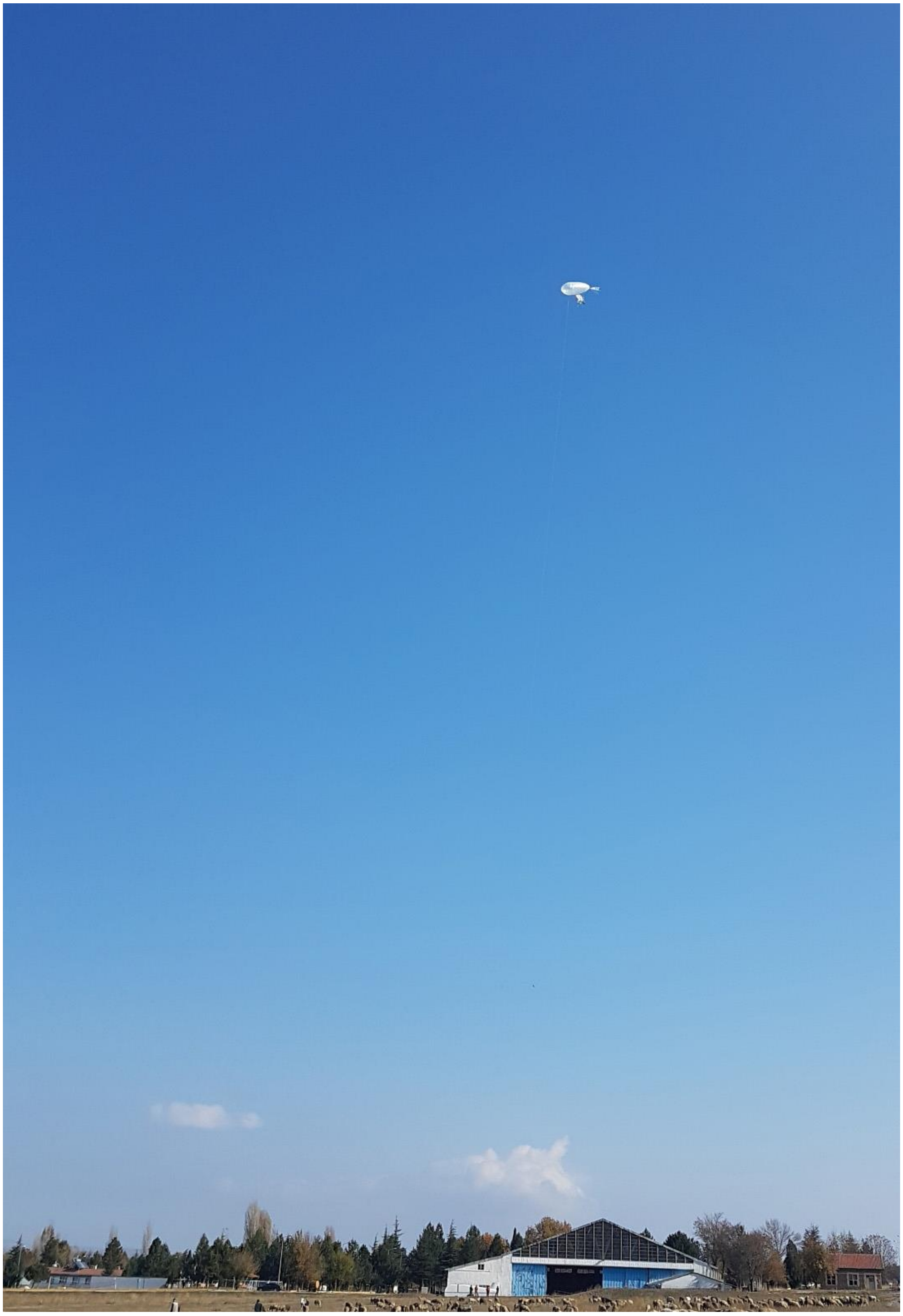
One of Demir's prototypes was tested by an independent institution to confirm its performance.

General characteristics of the Stage 1 aerostat

Parameter	**Stage 1 aerostat**
Envelope type	Superpressure balloon (SPB)
Length	13 meters (42.7 ft)
Diameter	310 cm (1 ft)
Volume	36 m^3 (1,271 ft^3)
Payload capacity, max	25 kg (55.1 lb)
Lifting gas	Helium
Wind speed for operation, max	30 kph
Propulsion	None
Endurance	1 year
Altitude, max operating	300 meters AGL

This aerostat can be scaled up to larger sizes. It is suitable for use in a variety of civilian or military applications that can be accomplished from a static location, including site surveillance and security, communication relay and advertising.

Tethered aerostat. Source: Mustafa Demir



Tethered aerostat. Source: Mustafa Demir

Stage 2: Develop and operate a mini-airship drone

Based on the gas envelope developed for the Stage 1 aerostat, the Stage 2 program focused on adding a propulsion system and flight controls to create a remotely-piloted drone airship.

Demir noted that several international mini-airship drones have their propellers positioned below the gas envelope (i.e., attached to a small gondola suspended under the envelope). This positioning can cause a pitch instability that is most noticeable during power changes, for example, a pitch up during a rapid power increase.

Source: Mustafa Demir

For his Stage 2 drone, Demir chose a propulsion system with three electric motor-driven propellers installed along the mid-plane of the gas envelope. Two propellers are located on the sides of the envelope and one is located at the tail.

The side-mounted propellers can rotate vertically to provide thrust vectoring. The propeller is mounted on a structural tube fastened to the envelope surface and supported by guy wires fastened to reinforced points on the envelope.

The primary goals of the drone testing program were to demonstrated controlled flight and gas tightness of the envelope.

General characteristics of the Stage 2 mini-airship drone

Parameter	Stage 2 mini-airship drone
Envelope type	Superpressure balloon (SPB)
Length	13 meters (42.7 ft)
Diameter	310 cm (1 ft)
Volume	36 m^3 (1,271 ft^3)
Payload capacity, max	21 kg (46.3 lb)
Lifting gas	Helium
Speed, average	30 kph (18.6 mph)
Propulsion	3 x electric motor-driven propellers
Endurance	2 hours
Altitude, max	300 meters (984 ft) AGL

This mini-airship drone can be scaled up to larger sizes. It is suitable for use in a variety of civilian or military applications that require a free-flying drone, including area surveillance and security, mapping, scenic photography / video, communications relay and advertising.

Source: Mustafa Demir

Stage 3: Demonstrate mini-airship drone materials and operation at high altitude

The goal of this stage is to test the superpressure balloon envelope and airship systems at higher altitudes, up to almost 10,000 meters (32,808 ft), and develop flight experience at high altitude. To reach that altitude without ballonets, the gas envelope needs to be able to expand by a factor of almost four.

General characteristics of the Stage 3 high altitude platform (HAP)

Parameter	**Stage 3 High Altitude Platform (HAP)**
Envelope type	Superpressure balloon (SPB)
Volume, at launch	16 m^3 (565 ft^3)
Payload capacity, max	1 kg (2.2 lb)
Lifting gas	Helium
Altitude, target	9,500 meters (31,168 ft) AGL
Altitude, maximum operating	9,827 meters (32,241 ft) AGL
Volume, at max altitude	About 64 m^3 (2,260 ft^3) (expansion factor of about 4)

As of 2021, the Stage 3 HAP airship has not yet made a high altitude flight.

For additional information

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/