

TITLE

Waste Tank for Vacuum Sewage System

Cross Reference to Related Application

5 This application is a continuation of copending
application Serial No. 08/434,638 filed May 4, 1995, which
is a continuation-in-part of copending application Serial
No. 08/325,750 filed October 20, 1994, which, in turn, is
a continuation-in-part of copending application Serial No.
10 08/138,308 filed October 20, 1993, now U.S. Patent No.
5,368,636, which, in turn, is a continuation-in-part of
application Serial No. 07/967,034, now U.S. Patent No.
5,284,507.

Background of the Invention

15 This invention relates to a waste tank for a
vacuum sewage system used in conjunction with aircraft
vacuum toilet systems.

 As disclosed in U.S. Patent No. 5,026,407, anyone
20 who has ever made a relatively long flight aboard a
commercial passenger jet is probably familiar with their
toilets. Flushing these devices results in toilet fluids
and solid wastes being drawn from a toilet bowl down a
waste line. Unlike conventional toilets, where waste
25 exits the toilet bowl via a circular water flow that
carries the waste through a bottom outlet, the toilets in
the most recent passenger jet models are vacuum toilets
that rely upon suction for removing waste. This creates
the familiar sucking sound that accompanies flushing this
30 particular toilet. A common attribute of such systems is
that a flushing airflow is created by venting toilets
externally of the aircraft. This is accomplished by
opening a valve, which creates an airflow path from a
given toilet bowl to the outside or ambient atmosphere via
35 a waste line and tank system. The pressure differential
between the toilet cabin and the outside is what actually
generates the airflow. At certain low elevations, where
the pressure differential is not great, a vacuum blower is

employed to assist or augment the natural pressure differential between inside and outside the aircraft.

Of course, the solid and liquid waste in the toilet is not simply dumped outside the aircraft.

- 5 Instead, it is separated from the airflow, and deposited in a waste tank prior to venting the air overboard.

Typically, the airflow and entrained waste travel from the toilet to the waste tank via conventional pipes or lines. The conventional waste tank has one or more
10 waste inlets configured to direct the flow circumferentially in a clockwise direction around the tank's interior, but at a level that is above and parallel to the level of waste already in the tank. As a result, a combination of centrifugal forces and gravity cause
15 separation of much of the entrained matter from the airflow, and it simply drops downwardly into the tank. Some entrained matter remains with the airflow and is removed via a separator as it exits the tank. This device is normally positioned inside the top portion of the tank.

20 However, when the tank reaches a level approaching the full liquid level of the tank, the kinetic energy of the sewage entering the tank causes splashing and creates waves which interact with the airflow causing more liquid to be entrained in the airflow than can be handled
25 efficiently by the separator. In this case liquid is exhausted to the atmosphere and forms ice on the aircraft exterior which then could break off and cause serious problems when it strikes the ground.

The waste tank system described above has sensors
30 for detecting the level of waste inside the tank. These sensors have faces that are positioned at a certain vertical height along the tank's inner wall, and provide an electrical signal indicating a full tank in response to contact with the waste as its level rises. In the full
35 tank condition, the level sensors remove power from all toilets connected to the tank.

The above-described tank inlet arrangement, which a circular flow motion inside the tank, also creates a problem in that it tends to coat the waste level sensor

faces with solid and liquid waste. This has been known to cause the sensors to emit signals falsely indicating a full tank, resulting in unnecessary shutdown of the toilet. This naturally results in a serious inconvenience
5 for the passengers.

The typical waste tank system also has one or more rinse nozzles that protrude into the tank. These are connectable to an external source of clean water for periodically rinsing and/or cleaning the tank during
10 aircraft maintenance intervals. They also tend to be coated by incoming waste from tank inlets which can clog them.

Summary of the Invention

15 A waste tank for a vacuum sewage system according to this invention is defined by a tank having a continuous sidewall, a top, a bottom, an inlet for admitting air and sewage tangentially into the tank, and an outlet for exhausting air separated from liquid from the top of the
20 tank. The inlet and outlet are above the maximum liquid filling level in the tank, and a shelf is attached to and extends from the interior surface of the sidewall of the tank and is located above said filling level and below said inlet whereby interaction between air being admitted
25 through said inlet and the liquid in the tank is reduced.

The shelf extends partially around the sidewall of the tank and is directed upwardly from said inlet.

The waste tank includes a rotary spray nozzle centrally mounted to said top of said tank through which
30 spray liquid is forced and which rotates by the reactive force of the liquid spray ejected from the nozzle, the nozzle being directed toward said sidewalls.

The tank is formed of a filament wound graphite ribbed structure impregnated with epoxy resin and has an
35 abrasion resistant fluorocarbon polymer coating on its inside surfaces.

The waste tank also includes a frame and means for externally supporting said tank from said frame and sensing the weight of said tank.

Brief Description of the Drawings

Fig. 1 is a perspective view of the waste tank of this invention.

Fig. 2 is a side elevation view partially in cross section of a waste tank showing the tank connected to a toilet bowl.

Fig. 3 is a transverse cross section of the tank of Fig. 2 taken along lines 3-3.

Detailed Description of the Preferred Embodiment

The embodiment chosen for purposes of illustration as shown in the drawings includes a waste tank generally designated 10 with inlets 14a and 14b, a separator 12, and a weight sensing system 16 supporting waste tank 10 on a frame 18.

The tank 10 is a filament wound, graphite epoxy, autoclaved cured structure. The curing method creates a low void structure allowing the tank wall to be the containment barrier preventing liquid penetration through the tank wall.

There is a coating on the inside of the tank of an abrasion resistant impregnated fluorocarbon resin material. The abrasion resistant material prevents damage to the tank wall when various solid materials enter the tank with waste. The fluorocarbon resin aids in cleaning when the inside of the tank is flushed with clean water. This also reduces the tendency of debris to stick to the walls of the tank.

The tank has integrally wound ribs 11. Since the system works on vacuum, the ribs increase the buckling resistance of the tank at a minimum weight penalty. Also the graphite epoxy structure is designed to work at a very low stress level yielding excellent fatigue life.

As best shown in Figs. 2 and 3, the vacuum waste system includes a toilet 20 connected to the tangential inlet 14a of tank 10 by a waste line 22. The toilet is flushed by opening valve 19 at the bottom of the toilet bowl which creates an air flow passage from the toilet 20 to a vent outlet 24. Solid and liquid waste inside the

toilet is drawn through the waste line 22 into tank 10 by the pressure differential between the aircraft cabin and the pressure outside the aircraft. The system may be provided with a blower (not shown) that assists the
5 creation of an airflow at lower elevations where there is not much difference between cabin pressure and pressure outside the aircraft.

A separator device 12 is shown mounted to the top of tank 10 above the full liquid level of the tank. The
10 separator includes dual filters 12a and 12b and incorporates through passages from air intake inlet 13 of the separator to outlet or vent 24. A skirt 12c isolates inlet 13 from the drain area 15 of the separator which reduces the possibility of any separated drainage liquid
15 being picked up by the inlet air and being recycled through the separator.

A rotary spray cleaning nozzle 26 is centrally mounted to the top of the tank and is connected to pressurized liquid source through passage 28 through which
20 spray liquid is forced from a source not shown. The spray nozzle is rotated by the reactive force of the liquid spray ejected from nozzle which allows the interior of the tank 10 to be cleaned because the interior surface of the tank is subject to the liquid spray.

A pair of shelves, shelf 30 and 31, are attached to the interior of sidewall 32 of tank 10 and extend into the tank from the sidewall. The shelves are located above the maximum filling level of the tank and below the tangential
25 inlets 14a and 14b of the tank. Inlet 14a interacts with shelf 30 and inlet 14b interacts with shelf 31. Each shelf extends partially around the sidewall and is directed upwardly at an angle A from a horizontal line 33. Angle A is preferably 5 degrees.
30

In operation, as shown in Fig. 2, the air and
35 sewage enters through tangential inlet 14a into tank 10 and falls to shelf 30 which provides the initial separation of liquid and solids from the air, i.e. the liquid and solids flow off the shelf into the tank and the air with some entrained moisture is directed upwardly to

the separator inlet 13 of separator 12 and does not interact with the liquid in the tank. Inlet 14b interacts with shelf 31 in a similar manner.

5 The weight sensing system incorporates three 5,000 pound load cells 16 (Sensotec model 31) supporting waste tank 10 from frame 18. Thus the sensing system is located externally to the tank.

10 The output of the load cells after conditioning goes through a microprocessor 17 to a readout. The microprocessor not only integrates and averages the weight, it tares out any acceleration effect from the system accelometer. The system will read the percentage full at remote locations and at the emptying station. This will allow a check before use. The design will tare 15 the system weight so any weight build up in the tank will be shown on the readout of the microprocessor.

What is claimed is:

1. A waste tank for a vacuum sewage system for serving the sanitation needs of aircraft passengers and crew, said tank having a continuous sidewall about a center, a top, a bottom, a pair of inlets for admitting air and sewage tangentially through the sidewall of the tank, and an outlet for exhausting air from the top of the tank, said inlet and outlet being above the maximum liquid filling level in the tank, and a pair of shelves attached to and extending from said sidewall into the tank, one shelf interacting with one inlet, the other shelf interacting with the other inlet, said shelves extending partially around said sidewall and being directed upwardly from the inlet that they interact with, said shelves being located above said filling level and below the inlet they interact with whereby interaction between air being admitted through said inlet and the liquid in the tank is reduced, said waste tank including a rotary spray nozzle centrally mounted to said top of said tank through which spray liquid is forced and which rotates by the reactive force of the liquid spray ejected from the nozzle, said nozzle being directed toward said sidewalls, said waste tank including a means for separating entrained liquid from air located in the top of the tank, said tank being formed of a filament wound graphite ribbed structure impregnated with epoxy resin, there being an abrasion resistant fluorocarbon resin coating the inside surfaces of said tank.

