THE GAMGRAM

No. 45 FLOATING SUCTION PROBLEMS APR. 1996

Floating suction assemblies are simple items at first glance. What can go wrong with a floating suction? Well, the float could leak or the swivel could stick, but what else? Years ago when we first started manufacturing them, we thought that was about it too. But over the years we have learned that there are many other things that can go wrong.

In one case, a large 16” diameter floating suction assembly that we supplied was sticking up out to the fuel so far that the inlet was in the air and the arm was empty. The operator could not get any flow. It was perplexing, to say the least.

Many of you are smiling right now, because you think you know why this happened, and most of you are wrong. The swivel did not stick, the retrieving cable was not tangled, and the arm was not jammed against a support column.

I will keep you in suspense no longer. The cause turned out to be that the operator had accidentally backfilled the arm with air. How? When they emptied another tank they had also emptied the suction line common to both tanks. When they then opened the valve on the tank that held our floating suction, the air in the pipe rushed into the floating suction arm, and the fuel in the arm rushed into the pipe. Before fuel in the tank could flow into the arm, the arm had already gained enough buoyancy to cause it to pop up, raising the inlet above the surface of the fuel. This is called a “floater”. OK, so some of you knew the cause, but not many!

The above problem can only happen on a tank with the outlet connection placed low on the side of the tank, but there are a number of things that can go wrong with any floating suction and we have decided to write this GamGram to list things that should be kept in mind when specifying or installing one.

1. As described above, floating suctions in vertical tanks (or horizontal tanks with end connections) should have one of the following:
   A. A small pipe with a manual valve can be run from the side of the tank to the suction pipe outside of the tank. This valve can be opened to fill the floating suction should it become a “floater” as described above.
   B. A small hole can be drilled into the side of the arm about a third of the way from the swivel to the float. This will allow the arm to refill should it become filled with air. This hole will allow the arm to draw a small amount of “less clean” fuel from a level in the tank well below the surface, but any negative effect will be small.
   C. A special valve can be added to the swivel. This valve is supposed to open and fill the arm should the arm fill with air. This sounds like a good idea, but valves of this type must be made very exactly, or they will either not work or will open under normal flow conditions and will be no better than the bleed hole described above.
2. Another problem experienced in floating suctions is similar, but can happen in any style tank. It also results in having a “floater”, but the cause is different. When filling an empty tank, the fuel level rises until it reaches the floating suction inlet. But because the inlet is turned downward, and the air inside the arm is trapped, as the fuel level rises, the arm floats up out of the fuel.

   This is the reason that many floating suction manufacturers (including GTP) drill small holes in the top of the inlet end of the floating suction elbow. As the tank fills, the fuel can enter the arm because the air can get out by way of these small holes. We us a 1/8” hole for arms up to 4”, and larger “bleed” holes for larger arms. Make sure your new floating suction has a bleeder hole before you close up the tank.
3. In horizontal tanks with top connections we have experienced many, many air problems – suction leaks. As described in GamGram 41, these problems are usually called pump priming problems, but are often caused by the floating suction installer. The problem is one of three things:
   A. The flanges are not parallel when the flange bolts are tightened.
   B. The gasket used is not compatible.

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C. The pipe connection in the roof of the tank leaks.

One reason for such leaks is that the contractor tests the piping without the floating suction installed. They never consider that the pipe INSIDE the tank could leak because they are concerned only with leaks that release fuel onto the ground.

The main problem is that the installer is usually standing on a ladder inside the tank, in poor lighting, and working overhead. It is very hard to get the pipe properly tightened into the tank roof in this position, and it is hard to bolt the flanges together in parallel. It is also critical that the flange gasket be compatible with the fuel. Believe it or not, the installers often are not that knowledgeable about gasket material.

These things may sound obvious, but we estimate that at least 25% of all horizontal tank fuel systems have problems as a result of suction leaks. These problems are usually falsely called "pump priming problems". See GamGram 41 for more on this.

4. Another problem is simply in choosing the incorrect size. If the floating suction is too small, you will have problems achieving the required flow rate. The reason is that the pump has to pull too hard, and the fuel breaks into vapor (OK, engineers, so it is a little more complicated than that, but we haven't the room here for a full technical explanation)

   First figure out the condition under which you will have the highest flow rate. This is usually during recirculation. We do not like to see velocities below 4 feet per second (FPS) or above 7 FPS. We have successfully achieved suction line velocities as high as 9 FPS, but only on jet fuels, and only on systems with above ground vertical tanks located close to the pump.

   You can perform the following calculation:

$$\frac{\text{FLOW RATE}}{(\text{PIPE SIZE})^2} \times 0.4 = \text{VELOCITY (FPS)}$$

   This is "Gammon's Formula" which we worked out after too many trips to the book of tables. It is very accurate and convenient. For example, let's calculate the correct pipe size for a floating suction and suction pipe for 200 gpm. A 3" pipe size would result in an excessive velocity of 8.9 FPS (feet per second). A 4" pipe gives a much better 5 FPS. (OK engineers, I know you know how to calculate net positive suction head and compare it to the pump curve, but not everyone does!)

   Pressure pipes, downstream of the pump, are smaller than suction pipe, because a little pressure drop does no harm here. (On the suction side too much pressure drop results in the fuel breaking into vapor and you lose flow rate). Pressure pipe and refueling hose for 200 gpm is usually 2", which is a fast 20 FPS.

5. Another problem usually blamed on the pump is a suction high point. The suction pipe used with a centrifugal pump should either be horizontal, or sloped slightly up to the pump inlet, with no "high points" to trap air. If there is a high point in the suction pipe, centrifugal pumps will experience problems similar to those of item 4 above. Positive displacement pumps are much more tolerant of high points.

   For example, if you plan to use an aboveground tank with a centrifugal pump, you had better not have the suction pipe leaving the tank at the top or you will have a serious high point. It is our understanding that all 50 states in the USA require "top connections", so it looks like you will need a positive displacement pump.

6. If you allow a floating suction arm to rise far enough, it will go perfectly vertical. If it does so, it will stay that way. For that reason, we design our smaller floating suctions to rise no more than 45 degrees, and never allow any floating suction to rise more than 55 degrees. How? By either having an arm long enough so that the float touches the tank roof before it reaches a high angle, or by attaching a cable from the tank bottom to the arm that restricts the angle that the arm can reach. We call this a "restraining cable."

   In a tank 35' in diameter and 40' high, the arm may be restricted to rise only 27' off the bottom when the tank is full, while the fuel level will be perhaps 38'. This may worry some of you, but the quality of the fuel at this level in the tank is not much worse than at the surface, and is much better than at the tank bottom. The only alternative is to put in an "articulated" floating suction arm, which has two swivels and arms. This is much more expensive and requires guide cables. We do make such designs, but recommend against them in most cases.

It is interesting that so much is important in the use of such an apparently simple device. For more information on fuel system design see GamGram 38 and GamGram 39. See GamGram 41 for pump priming problems.