FLOW BALLS

Understanding the use of a handy tool to help identify air flow in ports.

Flow Balls are a tool that upsets the air flow, positively or negatively. We use BOTH the positive and negative effects on air flow to learn and help us visualize what the air (which we can't see) is doing. From that, we can respond accordingly.

To begin, let's graph lift vs. flow. Start at 0" lift and don't forget to record leakage. Now we have a base line. Leave the valve at full lift and we'll initially start using our flow balls here.

When you insert a flow ball into a port, hold the rod parallel to the wall because we don't want the rod upsetting the flow. Watch for changes in flow and the magnitude of the change. Did it change a lot? - That area is very 'active'. Changes made there will affect air flow - positive OR negative. Did it change a little? Changes made there probably won't yield much return. Did it not change at all? That indicates a 'dead' area, a good place for fuel drop out, maybe it should be filled. Try filling it with clay and note any change.

Think of this; on a windy fall day, where are the leaves? In the air! What happens when the wind stops? The leaves drop to the ground. (hint) Where do the leaves collect around your house? Where the wind doesn't blow! So fuel collects at those dead areas. It might be on the wall behind the push rod choke area, or on the floor or in a corner. You've got to 'liven' up those dead areas. How? I can't tell you, every port is different. You've got to be smarter than the air. Try to 'set up' the air to go where you want it to go, upstream of that area/point. As you're moving your ball around you will feel the turbulence on the rod, you will sometimes hear a pitch change, and you will see a flow loss or gain. That is indicating a spot that needs some work. We use our ears to hear, hands to feel, and eyes to see the changes on the manometer, then our minds to visualize the air flow. It is a dynamic testing procedure. We are testing while air is flowing.

An ideal port is one, where, in any position, at any point, the flow ball will hurt the flow. This indicates that all surfaces are working. That is what we are aiming for. What size ball should hurt the flow? When the smallest ball hurts the flow the better our port is performing.

At a fixed distance inside the port, move your flow ball all around the port. Quite likely you'll see one side or an area which doesn't flow as much as the other. The ball will cause a reduction of flow on one side and no change at another point. The reduced flow results from the ball 'blocking', 'impeding' or 'killing' the flow, while no change of flow indicates the ball is located in a 'stagnant' or 'dead' area.

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Hold your flow ball very lightly between your fingers, a 5/16” or 3/8” ball works good for starters. Now enter the port and feel where the air is taking the ball. Probe the port all around but guide the ball very gently, let the air take the ball. Where is the air taking it? It is being shoved this way and that. Depending on the ball size, it will vibrate back and forth at certain spots. In certain areas the ball just does not want to be there! Can you visualize the air stream as it carries the ball? It is somewhat like holding a kite and watching where the air stream takes it. It will give you a good overall picture of and feel, through the rod, of the flow dynamics of the port. In this example you are using the ball as a kite.

Flow balls are a perfect tool to check corner radii. Start with your biggest ball at the mouth of the port and push it in until you get a change in flow. Then go to the next smaller, etc. Can you visually ‘see’ in your mind an ‘envelope’ area? Now do this to the other three corners. Next check the floor; place your flow ball, again starting from largest to smallest, dead center on the floor. Slide your flow ball in until you see a change. Now do the sides and the roof. You are ‘port mapping’ this port in your mind. Can you ‘see’ what is happening in all four quadrants? What happens as you move towards the valve? This combined with flying your flow ball kite should give you a pretty good indication of where the air is in the port and how fast it is going.

While you were mapping the port, you should have heard, with your ears, a change of pitch. That is telling you something! Now here is where we have to figure out what the ball is doing. Visualize a river with a rock in it. What is happening at the front/ sides/ back of the flow ball, or rock? Pressure is building at the front and flow is separating at the trailing end. The flow separation creates vortices where the flow at the trailing end of the rock is turbulent. If we put another rock behind our original rock that would help straighten the flow. This is where it gets tricky. OR, if we put a larger rock in front of our original rock, the smaller rock behind our larger one will help ‘straighten’ the flow. Which is it? Try the different size balls to determine which it could be. Does your river of air sound smooth or are there lots of rocks and water falls in it?

What about when the port sounds really good up to a certain lift point then starts sounding harsh up to maximum lift? Don’t try to fix it at maximum lift, reduce your valve lift to where it just starts to sounds harsh. That harsh sound is when the air is separating from the wall. Fixing it at this point could cure it at maximum lift. Start there and work your way to maximum lift. It should sound smooth and consistent.

If your test pressure is fluctuating all over the place it’s usually caused by an unstable situation as the air approaches the valve seat. The noise will vary with the test pressure; as the test pressure goes up, the noise will go up, and vise

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versa. The air is separating, then reattaching. As the test pressure goes up, the flow goes down (inverse relationship). Try probing with different size balls. What area or position in the port did the ball cause the flow to stabilize?

If you put a ball in just before the short turn and you pick up flow it might be telling you; the vortices created behind the ball is reattaching the flow. Did the sound transition from 'harsh' to 'smooth'? It should have. OR, there might be something upstream that the ball is straightening out. The 'trip' off the back of the ball might be causing an attachment, or the front of the ball might be acting like a small rock behind the larger rock. Probe the port with the different size balls in that area moving in and out, up and down. This is not limited to the short turn. Flow might be separating around a corner at the push rod. Or it might be that your air speed is too high. Check with a pitot tube, 380-400 feet per second (at 28" of depression) is too fast. (If your velocity probe is attached to a manometer, it will read approximately 38" H20) If your speed is too high, slow the air down by increasing cross sectional area. Where? I can't tell you, but don't do it in a 'dead' area. If your speed is OK then the port shape could be the problem, or it might be in the combustion chamber.

If you have a problem that the flow ball 'fixed' try going upstream with different size balls. Your port should sound smooth and consistent. Always work as far upstream of your problem as possible. Sometimes that will cure two problems down stream in the air flow path.

Now let's look at the flow vs. lift graph. Are there any dips or irregularities? Set the valve at that lift and probe the port with different size flow balls. Probe to look for areas of sensitivity. Watch the position of the ball where it increases the flow and where it has no effect on the flow. Analyze it. Is it the front or the back of the ball that is turning/tricking the air? This would be a good time to use your 'flags'. Use the 90º rod and drag the ball end on the port wall. While working your way towards the valve, zig zag across the floor, then sides, and roof watching the string. Is it in 'line' with the port? Or at a certain point does it change direction? Does the string stay 'attached' to the wall or does it 'lift' off? If it lifts off, where does it point? What size ball can you put in at that point that will hurt the air flow? Try and pretend you're an air molecule, and you hate to turn corners.

I know it takes more time, but try to record the effect of each test. Yes, you wind up with LOTS of data. But all that data can be useful! It's telling you a story, and you can determine the ending of that story! So when you can't figure out what the next page should read...take a break! Go outside and walk around the shop, pet your dog, call your wife up and tell her you'll be home on time tonight! Then start fresh and new tomorrow.

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