Motorcycle fuel injection handbook pdf

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Fixed jet carburetors: Bendix, Tillotson, Keihin and Mikuni Chapter 9: Ancillary parts Chapter 10: Fuel injection: adjustments and setting Chapter 11: Supercharging and special fuels Chapter 12: Fault finding Chapter 13: Overhaul Connecting the dots to deliver the correct fuel mixture for every conditionNovember 28, 2018More Bikes What fuel injection does makes what carburetors do seem like little more than guessworkApril 7, 2018More Reviews To adjust the throttle valves, screw the bypass screws in or out until all gauges show the same readings. By doing this, the small air gap opened up by the throttle valves when idling is adjusted so that air is sucked into the combustion chambers on all cylinders at exactly the same vacuum and at the same rpm, and thus the engine works uniformly on all cylinders. As a rule, when adjusting the throttle valves, the aim is not to set a specific vacuum – most motorcycle manufacturers do not specify one. The important thing is to achieve the same value on all the throttle valves. Then the system will work "in sync" for all cylinders. If one gauge shows a completely different reading from the others, this may indicate that the basic setting of that throttle valve is completely wrong, or it may mean there is a fault or damage, such as loss of compression on one cylinder or a leaking intake manifold. If you cannot find and rectify the fault yourself, then you must go to a motorcycle workshop.The throttle valves are adjusted using the so-called bypass screws (see Step 7, Fig. 1). Never touch other sealed or colour-coded adjusting screws! All bypass screws should be open at least half a turn. EFI no more fueling aroundOctober 28, 2009More Motorcycle Cruiser Motorcycle fuel injection systems are very similar to auto fuel injection systems. Basically, it is a pulsed preassure spray of fuel into the cumbustion chamber. The systems tend to use a traditional low pressure rail configuration. Although motorcycle systems tend to be open looped (exept BMW) they can have other high performance advantages like sequential injector firing, multi-hole injectors, and 32-bit processors. Open Loop vs. Closed Loop Most motorcycles currently use open loop systems. An open loop system is basically a system without feedback adjustment. The system does not make any adjustments if the fuel mixture is not burning well. Thus, a system can run rich or lean at any given time with no correction. These systems may or may not have an oxygen sensor, but this is for another feature. A motorcycle with a closed loop system will usually have a caytalitic converter like a car. An narrow band oxygen sensor up stream of the catalizer senses unburned oxygen and sends a signal to the ECU that will allow the ecu to correct the mixture for the next firing. If a catalizer is place on a system unable to correct mixture, eventually the exaust gasses will go out of permissable range of the catalizer and the catalizer will get overloaded and fail. Why Adjustment is Necessary Stock bikes need to be re-jetted or mapped to get maximum power or efficency. Bikes are designed with fuel systems that are compromised so that they can pass noise, emissions, and economy standards around the world. This, not to mention all of the different gasoline formulas available. Once these factors are worked out, then they power is maximized within those constraints. This graph clearly show that any manufacturer is going to build a system that provides a lean mixture for fuel economy, or just slightly rich for minumum emissions, but far from the rich mixture neccessary for maximum power. Bosch Fuel Injection & Engine Management (Probst, 1991) Exhaust, intake, and other power enhancing modifications usually contribute to an even leaner mixture. Even bikes with closed loop injection systems will need to be adjusted for maximum power. These systems are programed to produce a mixture that is perfect for the catalizer to clean. Bosch Fuel Injection & Engine Management (Probst, 1991) Adjustment Hardware and Software The Dynamometer A custom map can be made by using a chasis dynamometer. This tool measures torque at the rear wheel at various RPM. An exaust gas anylizer is also used to quicken the process, but the goal is to make as much torque as possible at a given RPM regardless of gas output. Dynojet Mustang Superflow Cycledyn The Mobile EGA & Logger A mobile EGA can be used on the bike for real time readings and logging of exaust gases. This is a nice tool for the home or small time mechanic, but does nothing to ensure maximum torque, just burn. This technique also suffers from instrument lag time for readings. Handy 16566 Wide Band Commander Comercial and Custom Maps Usually, on high performance machines the lean conditions programed into the EMS are most pronounced a between 0 and 20 percent throttle opening and in lower rpm's. Goverment test procedures usually point to where the mixture will get leanest. Since the tests are rarely conducted at WOT and near redline, the system is probably running best in that range. Dynojet's press on the need for a custom map. The custom map is next. The standard maps that Dynojet and other manufacturers provide are created using what ever bike happed to be available at the time, in whatever state of tune it happened to be in. By paying a specialty shop, Like Factory Pro to create a custom map for my exact bike, the power is then optimized and throttle response improves greatly. This map created for me was with stock unmodified exhaust and stock air filter with the fire screen removed. PAIR and SMOG systems have been removed as well. Otherwise, the bike's powerplant remains stock. The bike was dynoed with Mobil 1 EP 15W-50 lubrication (reducing power just slightly), a 520 chain (raising power slightly) and watter wetter coolant (cooling the engine more). Notice that the bike, stock, was mapped too lean to about 40% throttle, then gets too rich to 100% throttle. This trend will be seen on most bikes. Why? Simple, the bike is lean at first so that the bike will pass emmisions regulations and testing, then it gets rich so that the bike will run well enough, under hard use, if the end user puts an aftermarket pipe on the bike. This is what a power commander will fix. HERE is the map file. This is what the Dynojet map looked like. Pretty crazy. You can tell that they just hooked it to the computer and let 'er rip. There is no way a quality map could look like this. When a custom map needs to be changed A custom map needs to be changed when: A tuning parameter of the intake or exaust system is changed A tuning parameter of the fuel delivery system changes A tuning parameter of the ignition system changes The motor condition changes The location (altitude or region) of the bike changes The fuel type is changed Power Commander Instalation 4 bypass connectors at each of the lower injectors and one bypass connector at the throttle position sensor, then a simple ground to the battery. It is very important to calibrate the throttle position sensor to the power commander when installing. 1% error could make all the difference Bibliography Bosch Fuel Injection & Engine Management. Charles Probst. 1991. Bentley Publishers. Motorcycle Fuel Injection Handbook. Adam Wade. 2004. MBI Publishing. External Links Wikipedia - Fuel Injection Wikipedia - Dynamometer Wikipedia - Oxygen Sensor Starting at the airbox, through the carburetor and fuel injectors, and ending at the tip of the exhaust tailpipe, the Motorcycle Fuel Systems Techbook by Haynes covers it all!But the book does not stop there. Other systems such as turbochargers, superchargers, fuel pumps, electronics, funny fuels and testing equipment like dynos, are also covered. Book Excerpt: Motorcycle Fuel Systems Techbook: All Carburetor Types and Fuel InjectionCARBURETOR CONSTRUCTION AND ADJUSTMENT INTRODUCTIONDespite the enormous range of motorcycle engine size and types since 1950, carburetor design can be condensed down into something like four basic formats. Different makes of carburetor obviously have their own features and style, but if you are familiar with the basic family type, you can quickly find your way around any carburetor.There are a few particular makes that have either been used on a wide variety of machines or, if not used themselves, have influenced other designs that were. It is worth looking at them in some detail, partly to see how their influence has permeated through to current design (in fact some of them are still current). The other part of the reason is that many of these carburetors will be fitted to older, now classic machines and will need to be restored and overhauled, so some detail explanation may be useful.There are plenty of other carburetors used on bikes but not mentioned specifically in this Chapter (eg Bing, BVF, Hitachi, Jikov, TK(TeiKei) and Weber) but their construction and operating principles are very similar to the types that are described. ANCILLARY PARTS PRESSURE REGULATORSTo keep fuel rails at a constant pressure, the pump is given more capacity than the engine needs and excess fuel in returned to the tank via a pressure regulator. This takes the form of a pressure vessel in which a piston is sealed by a diaphragm and held under spring tension. When fuel pressure on the opposite side is greater than the spring force it lifts the piston, opening a valve which returns fuel to the tank. As the pressure drops, the spring pushes the piston back to close the valve. Usually the non-fuel side of the piston is vented to one of the intakes downstream of the throttle valve, so the fuel pressure is always a constant amount above intake air pressure. This is essential in supercharged applications.Some regulators have an adjusting screw that alters the preload on the spring, so the lift-off pressure can be regulated. Raising the pressure in a fuel injection system has the effect of richening the mixture all the way through the range.Regulators are tested by applying pressure, either from a pump with a pressure gauge or a deadweight pressure cylinder, to see if the valve opens and closes within the specified range. Kerosene, as a less volatile and ignitable liquid, is used for this kind of test.All carburetor types, along with li> Overhaul fuel injection, from basic theory to practical tuning.Note: this book supersedes #603 Motorcycle Carburetor Manual by Haynes. Subject: Motorcycle fuel systems manual: service, maintenance, repair. ISBN-10: 1859605141 | ISBN-13: 9781859605141 | Haynes 3514 Fuel injection has been around on bikes for a while now, and it's here to stay. Given the right information, properly set-up fuel injection can deliver the correct amount of fuel at any time, under any conditions. And an engine can't ask for more than that. The mechanics of fuel injection are pretty simple. A pump delivers pressurised fuel to the injectors, positioned in the throttle bodies through which air to the engine. The injectors are roughly spark plug-shaped, and contain a solenoid-operated valve which, when activated by the bike's electronic brain (the ECU), opens and allows a pressurised squirt of fuel into the airflow. The amount of fuel injected is determined by the length of time the valve is open. The valve's movement is measured in thousandths of a millimetre, and the opening time measured in milliseconds.The clever bit is how the ECU decides how long the injector's valve needs to be open. It does this by measuring a whole load of engine parameters - throttle position, engine speed (rpm), engine temperature, intake air pressure, which gear the bike is in, plus any number of others depending on how advanced it is - then calculating how much fuel is needed by comparing the values to masses of pre-determined criteria. For example, if the engine is running at 80°, on three-quarters throttle, in fifth gear, at 7523rpm and it's pretty cold outside, the ECU cross-references all that data with the pre-programmed information and knows just how long to open each injector for. That pre-programmed data is known as a 'map', and it's this that gets changed when a bike is tuned with an aftermarket add-on like a Dynojet Power Commander or Yoshimura EMS Box. The information itself comes via sensors attached to various bits of the bike. Occasionally - although not often - these will fail, and a warning will be displayed either with a flashing light on the instrument panel or a failure code on the bike's LCD display. The more information the system has to work with, and the faster it can be dealt with, the more precise the fuel delivery. Recently we've seen a shift from 16- to 32-bit processors, enabling faster processing of more data. But bikes have a long way to go to match the car world. A bike's ECU is doing well if it can cope with 4,000,000 instructions a second; BMW's new M6 has one of the most powerful engine management systems yet developed, boasting over 200,000,000 operations a second as it deals with data from more than 50 sensors.Bikes have yet to need such complex systems, although it won't be long if emissions laws keep getting stricter. So is fuel injection always better than carbs? "If manufacturers get everything right then fuel injection is better every time," reckons FW Development's Frank Wrathall. "It gives us greater control over fuelling so we can control emissions better. From a tuning point of view the only exception I can think of is the Yamaha R6. Tuned, pre-injection R6s make more power than tuned injected ones. Part of the reason is that the engine has basically been retro-fitted with injection rather than designed around it."That example aside, fuel injection has other advantages over carbs. From a tuning point of view, it's a lot easier to adjust fuel injection than it is to repeatedly strip, adjust and rebuild a set of carburettors. Simply plug in a laptop and do it with a few keystrokes. You need to know exactly what you're doing, but the same applied to carbs - only a different set of skills are needed.The other advantage fuel injection has over carbs is its physical size. Four injectors, their throttle bodies and fuel supply take up far less space than a bank of carbs. This gives manufacturers far more scope for angling inlet tracts as vertically as possible, so gravity can give the incoming fuel/air an added boost. It also gives more flexibility for the positioning of airbox and fuel tank, used to great effect by Honda with their mass-centralised CBR600RR and Fireblade, whose fuel tanks inhabit the space where, a few years back, carbs and airbox would live. V-configuration engines benefit too, notably Honda's V-fours, which always struggled for space between the cylinders. The RC45 had to be injected - there wasn't enough room to fit carbs big enough. There was another advantage: the space between the V-four motor's cylinders is one heck of a heat trap, and fuel sitting in the carbs' float bowls could vaporise. Fuel injection's pressurised supply solves that problem too.NIALL ON INJECTIONMany racers' first impressions weren't exactly positive, as Niall Mackenzie recalls: "My first experience of fuel injection was riding the Virgin Yamaha R7 in 1999. At that point the team didn't have the information to set the bike up. Yamaha were in the dark too and struggling with Haga in World Superbikes. The biggest problem was our limited mapping knowledge. We'd set the ECU up and the bike would run fine, then the weather would change, the ECU would over-compensate and the bike wouldn't run right. We ended up picking a setting that worked then disconnecting everything so the system couldn't change. "Initially I disliked fuel injection. Carbs gave a nice progressive feel which injection didn't have then. With fuel injection you'd get a kind of dull spot in pick-up going from a closed to open throttle. It wasn't smooth, not all-or-nothing but a bit clinical and a bit hit or miss. "Now injection is pretty refined and very difficult to fault. I never really think about it now. When I test a new bike or go on a launch I'm really conscious of throttle response but it's getting very hard to pick faults, especially with the new 600s. "Of course the only disadvantage with fuel injection now is that you can't do backfires."MAKING IT EVEN BETTERWhile bike fuel injection systems are bringing up the rear in technology terms, they are evolving. We're now seeing more bikes appear with various configuration of dual injector set-ups. The problem with a single injector set-up is that for optimum low- and medium-speed running and a quick throttle response you want to place the injector close to the inlet port. However, at higher engine speed it's preferable to place the injector further back so the fuel has more time to atomise before it reaches the cylinder. The solution is to fit two injectors, one close to the cylinder and one further back. Honda's dual injector set-up, first seen on the CBR600RR, mounts the second injector high in the airbox, pointing vertically down into the throttle body like a shower-head. Suzuki's take, seen on the 2005 GSX-R1000, puts the secondary injector above the first, but downstream of the secondary throttle valve and angled obliquely across the airflow, rather than more directly into it as the primary injector is.In each case, the secondary injector only operates above certain rpm and throttle openings. This also allows the increased fuel flow to neatly side-step emissions regs, testing for which is carried out before the secondary injector comes into play. Advances in injector technology have seen manufacturers experiment with different types of single and multi-hole injectors in an effort to deliver a finely atomised spray of fuel into the inlet tract. Suzuki currently opt for a four-hole injector, while Honda are using 12-holes on their shower-head set-up.The standard hardware is up to the job, too. "A 1000cc motor is good for 220bhp on standard injectors," reckons Frank, "and Hayabusas can be tuned for 300bhp on standard equipment. Standard injectors, pump and fuel pressure is ample for anything you could choose to do."But while the hardware is good to go, standard maps can leave a lot to be desired."Fuel injection is only as good as its map," explains Frank. "Some are horribly wrong, and none are right everywhere. But it can't be absolutely right because manufacturers' hands are tied by regulations. A rich mixture flattens the exhaust note, so some bikes run rich where the noise test is carried out. People think Power Commanders are only relevant to modified bikes, but every fuel injected bike can have its map improved." Frank Wrathall is the 'FW' behind FW Developments, one of the most successful tuning outfits in the country and the name behind some of the fastest motors in BSB. He also heads up Dynojet UK, so knows as much as anyone about getting the best out of fuel injection systems. And good old carburettors, for that matter.FW Developments are on (01995) 600680 or www.fwdevelopments.comFor Dynojet UK call (01995) 600500 or go to www.dynojet-uk.comGiven the right information, properly set-up fuel injection can deliver the correct amount of fuel at any time, under any conditions. And an engine can't ask for more than that.The mechanics of fuel injection are pretty simple. 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