Evaluation of Motorcycle Evaporative Canisters

Final Report

Manufacturers of Emission Controls Association
www.meca.org

July 15, 2021

Table of Contents

Background

- MECA wishes to acknowledge that five of the six motorcycles evaluated under this testing program has been certified to and is compliant with existing US EPA and CARB Tier 2 emissions standards. One motorcycle examined is compliant with Euro 5 Type Approval requirements.

- In support of a proposed On-Highway Motorcycles (ONMC) Rulemaking, CARB evaluated existing canisters on ONMC and the ability for the existing evaporative emission system to meet a three-day diurnal standard.
  - CARB observed ONMC appear to have limited evaporative control as compared to passenger cars, that evaporative emissions varied significantly among different bikes, and that a Euro5 compliant motorcycle did not provide improved evaporative emissions performance.

- An opportunity exists to advance evaporative emission requirements on ONMC to improve emissions control beyond current CARB and Euro5 requirements.
  - In particular, as many ONMC are infrequently driven and have relatively long calendar lifetimes, it appears that the current 1-hr diurnal standard of 2 g/test and the Full Useful Life Standard of 35,000km may be inadequate to control excessive diurnal emissions over the calendar lifetime of most motorcycles.
  - MECA believes updated test procedures and limits for on-road motorcycles are needed to reduce emissions to representative levels of current evaporative control technologies.

Study Objectives

- MECA supported CARB and EPA to evaluate the opportunity for evaporative emissions reductions on ONMC.
  - EPA evaluated Class 1A & II motorcycles while CARB tested Class III motorcycles for 3-day diurnal emissions to quantify the contributions from canister emissions, leaks, and other sources.

- The study had the following objectives:
  1. Determine appropriate design criteria for meeting a 3-day diurnal standard across a variety of fuel tank sizes from 1-5 gallons.
     - e.g., Butane Working Capacity (BWC)/fuel tank volume ratio, canister length:diameter ratio, carbon durability specification, etc
  2. Determine a relationship between butane working capacity (BWC) and gasoline working capacity (GWC) for testing adsorption capacity of carbon currently used in on-road motorcycles.
  3. Evaluate the carbon deterioration rates and determine appropriate durability testing criteria.
  4. Engineer a new canister prototype to determine if BWC/fuel tank is a valid way to reduce evaporative emissions.
     a) Determine if advanced carbon materials or improved canister designs can be used so that current canister sizes can be retained and comply with existing space limitations.
  5. Determine if a design criteria based system can realize evaporative emission reductions

- MECA completed the following:
  - Evaluated 7 canisters for 6 different motorcycles tested by CARB and EPA
    - A range of canisters and fuel systems from 125cc to 1750cc, with various fuel tank sizes and canister designs.
    - Data obtained included canister design features, carbon properties, BWC, GWC, and 3-day diurnal canister bleed emissions
  - Designed one prototype canister based on the best performing systems (lowest 3-day diurnal emissions) that was used by CARB to validate if compliance of the worst-evaporative emitting bikes could be improved to the range of the lowest-evaporative emitting bikes.

Motorcycles Reviewed in this Study

Motorcycle	Displ. (cc)	Rated Power (kW/hp @ rpm)	Engine & Emissions Systems Specifications	Fuel Capacity (L / gal)
2019 Honda Supercub C125	125	9 / 12.3 @8750	1cyl, 4stroke, 2vpc, SOHC, SFI, O2S, TWC(2), 4spd auto EVAP KHNXU0006UXB	3.78 / 1
SYM Wolf 300	278	20 / 26.8 @8000	1cyl, 4stroke, 4 vpc, SOHC, SFI, 6 spd	14 / 3.7
2015 Honda VT 750	745	32.8 / 44.9 @5500	2cyl, 4stroke, 3vpc, SOHC, SFI, 2OC, PAIR, 5 spd EVAP FHNXU024UZE	14.6 / 3.9
2020 Triumph Street Triple	765	89.8 / 123 @11750	3cyl, 4stroke, 4vpc, DOHC, SFI, O2S, TWC(2), PAIR, 6 spd EVAP LTDXU0018DES	17.4 / 4.6
2018 Suzuki GSX-R 1000	999	135 / 185 @11500	4cyl, 4stroke, 4vpc, DOHC, SFI, H02S, TWC, PAIR, 6 spd EVAP JSKXU0024YT3	16 / 4.2
2019 Harley Davidson Street Bob	1746	62.8 / 86 @5020	2cyl, 4stroke, 4vpc, DOHC, SFI, 2H2O2S, 2TWC, 6 spd EVAP KHDXU0025ACA	13.2 / 3.5

Test Procedures: Canister Butane Working Capacity (BWC)

Canister Butane Working Capacity was determined following EPA light-duty test procedures outlined in 40 CFR § 86.132-96(h)(1)(i-iv), with clarifications made to adapt the procedures for motorcycles:

- The new test canister is loaded with 50:50 vol% butane-dry air at a rate of 15 g/h butane until 2g of breakthrough is detected.
- Within 2 minutes, the canister is then purged with pressurized dry air (in the opposite flow direction) at a rate of 22.7 L/min for 300 bed volumes.
  - After another 2 minutes of soak time, this test sequence is then repeated for a total of 10-20 cycles (until stabilization of new canister BWC is achieved) to stabilize new canisters.
- The reported BWC is calculated as the average mass increase of the last three load and average mass loss of the last three purge cycles and does not include the 2g of breakthrough during the loading cycle*

*MECA, EPA, and CARB agreed that including the 2g of breakthrough was not appropriate for the smaller motorcycle canisters.

Test Procedures: Canister Gasoline Working Capacity (GWC)

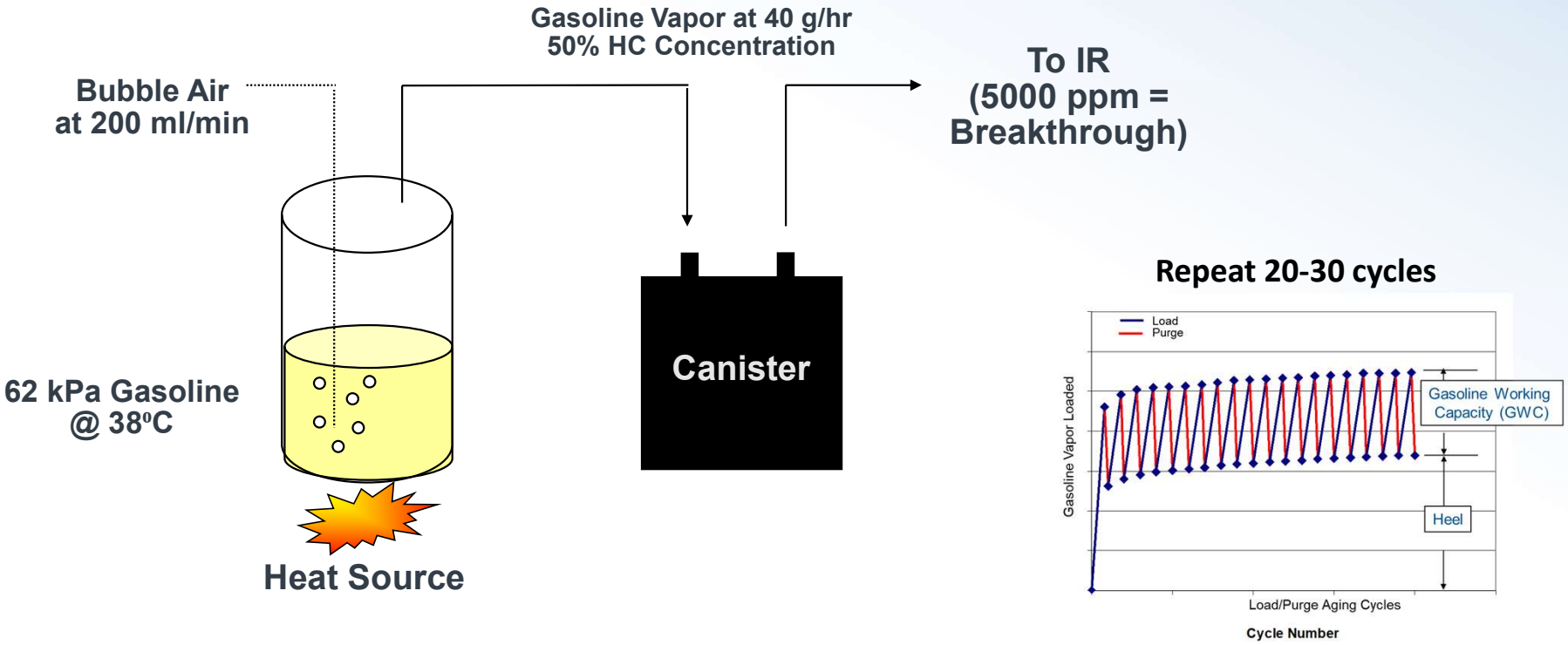
- CARB light-duty vehicle regulations for the bleed emission test procedure (BETP)[1] specify conditions for loading and purging a canister with gasoline vapor.
  - A canister system is loaded to 2-gram breakthrough with either a mixture of fuel vapor and nitrogen (50 ± 15 percent fuel vapor by volume) or a mixture of fuel vapor and air (50 ± 15 percent fuel vapor by volume), at a fuel vapor fill rate of 40 to 80 grams per hour. Each loading is followed by purging the canister system with 300 canister bed volume exchanges at 0.8 cfm (22.7 L/min).

- MECA determined GWC by following the CARB BETP procedures with the following conditions:
  - A test canister is aged by bubbling dry air at a rate of 200 mL/min through 2 liters of Tier 3 (E10, 62kPa) gasoline fuel heated to 38°C. The air flow rate is controlled using a mass flow controller. Under these conditions, the vapor generation rate is about 40 g/h and the hydrocarbon concentration is approximately 50% (volume). These vapors are introduced to the canisters until breakthrough of 5000-10000ppm is detected at the atmospheric port and the 2 liters of liquid gasoline is replaced.
  - Within 10 minutes, the canister is then purged with pressurized dry air (in the opposite flow direction) at a rate of 22.7 L/min for 300 bed volumes. This sequence is repeated for a total of 20-30 cycles. The resulting GWC is calculated as the average of the last three load and purge cycles and does not include the 2g of breakthrough.

- For data MECA presents as "aged" represents canisters treated with 300 cycles of GWC prior to conducting a BWC or BETP test.

[1] See Section 12.1.2 of CALIFORNIA EVAPORATIVE EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES, as Amended September 2, 2015.

Test Procedures: Gasoline vapor generation for GWC



Test Procedures: Bleed Emission Test Procedure (BETP)

MECA followed CARB light-duty vehicle regulations for the bleed emission test procedure (BETP)[1] with the following modifications to adapt the procedure for motorcycles:

- Canister Stabilization:
  - Rather than a stabilization on the motorcycle, it is proposed to cycle age the canister no less than 25 GWC cycles following the procedures for GWC referenced on Slides 7-8.
- Leak Test:
  - Prior to BETP testing, a leak test on the entire fuel system was performed to assure that the emissions only originated from the canister. If leaks were determined, steps were taken to eliminate the leaks (replace or repair leaking components or use of appropriate sealing measures).
- Fuel tank drain and fill:
  - The OEM motorcycle tank is filled to **40%**[2] of the nominal volume with LEV III fuel (CA RFG3, 10% ethanol) and given time (>6h) to adjust itself to a temperature of 18.3°C within a temperature-controlled chamber. Connections to canister made using OEM fuel lines or low permeation Tygon hoses.
- Carbon Canister System Loading prior to BETP test:
  - The test canister is loaded with **50:50 vol% butane-dry air at a rate of 40 g/h** butane until **2g** of breakthrough is detected at the outlet. After a 60 minute soak period at ambient temperature (24°C), the canister is purged using **300-310 bed volumes**[4] with pressurized dry air at a rate of **5-10 L/min**[3].
  - After a 16h soak period (during which the canister is plugged) at ambient temperature (24°C), the test canister is connected to the tank (as prepped per the direction above) via its load port and a Kynar® bag is connected to the atmospheric port.
  - The chamber is programmed to control the temperature based on the US CARB diurnal temperature profile (**18.3 - 40.6 – 18.3°C**). BETP testing is run for **3 diurnal profiles**. After 6h, the bag is removed and replaced with a new one. The emissions in the removed Kynar bag are measured by an FID. After 12h, the second Kynar bag is removed and also measured by an FID. The canister is weighed and reconnected to the tank. During the next 12h (the cool-down portion of the diurnal cycle), no bag is attached to the canister to allow for back-purge. The same procedure is repeated on the second day and **third day**.

Note: Since actual purge data (rates and total volume over a given drive cycle) and hot soak loading for the motorcycles was not known prior to BETP testing, MECA repeated BETP tests at 100 bed volumes of purge to represent a canister state that was not fully clean or purged. BETP test with 300 bed volumes of purge represent a condition of starting with a fully purged or clean canister.

[1] See Section 12.1.2 of CALIFORNIA EVAPORATIVE EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES, as Amended September 2, 2015.
[2] Motorcycle confirmatory testing uses 50% fill, but during the drive cycle would consume ~10%. MECA, CARB, and EPA agreed on 40% and noted this would be worst case.
[3] It was discussed with EPA and CARB team that rather than using the 22.7 L/min specified in the CFR and CARB procedures, due to the smaller size of the motorcycle canisters, a range of 5-10 L/min would be more representative of actual purge rates and would allow for purge to be better controlled.
[4] EPA has previously suggested canisters be benched purged to a "clean" state before SHED/bleed test. 300 bed volumes was discussed as representative of the volume needed to clean a canister.

Diurnal Canister BETP Emission Testing Comparison

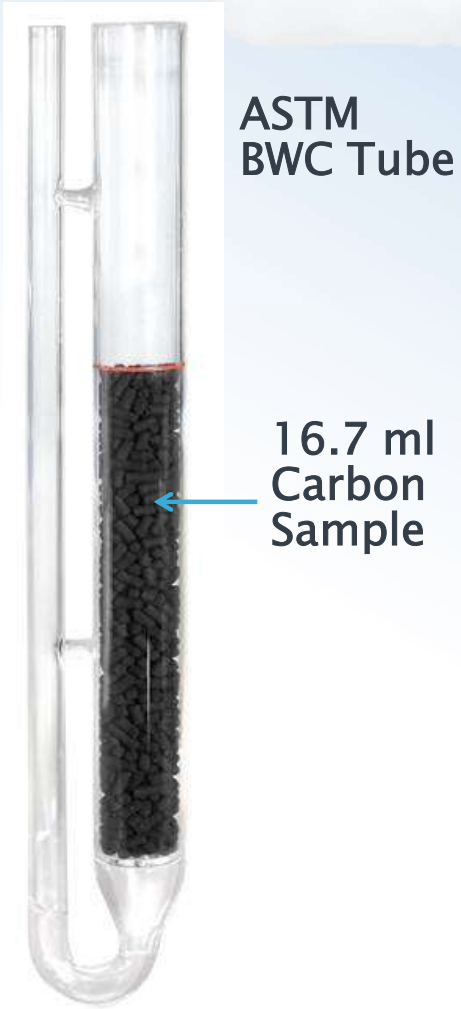
CARB temp cycle, LEV III fuel, 40% fill, purge rate 10l/min

Picture: Diurnal canister emissions testing followed the “Bleed Emission Test Procedure (BETP)”

Carbon Characteristics

Butane Working Capacity (ASTM D 5228)

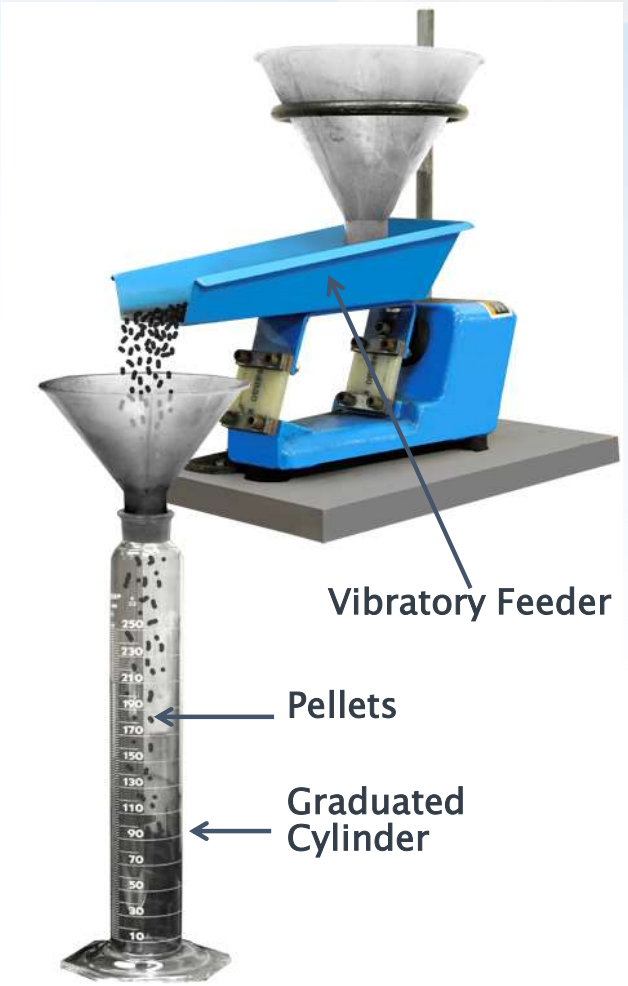
- Simple test to tell how well carbon contains gasoline vapors
- Saturate the 16.7 ml Carbon Sample with 100% Butane at 25° C
- Purge using 300 ml/min dry air for 40 minutes (or 719 bed volumes) at 25ºC
- The weight loss after purging is the Butane Working Capacity (BWC) and is usually expressed as " g/100 ml "
- Bed Volume (BV) = $\frac{Liter\ of\ Air}{Liter\ of\ Carbon}$



Carbon Characteristics

Apparent Density
(ASTM D 2854)

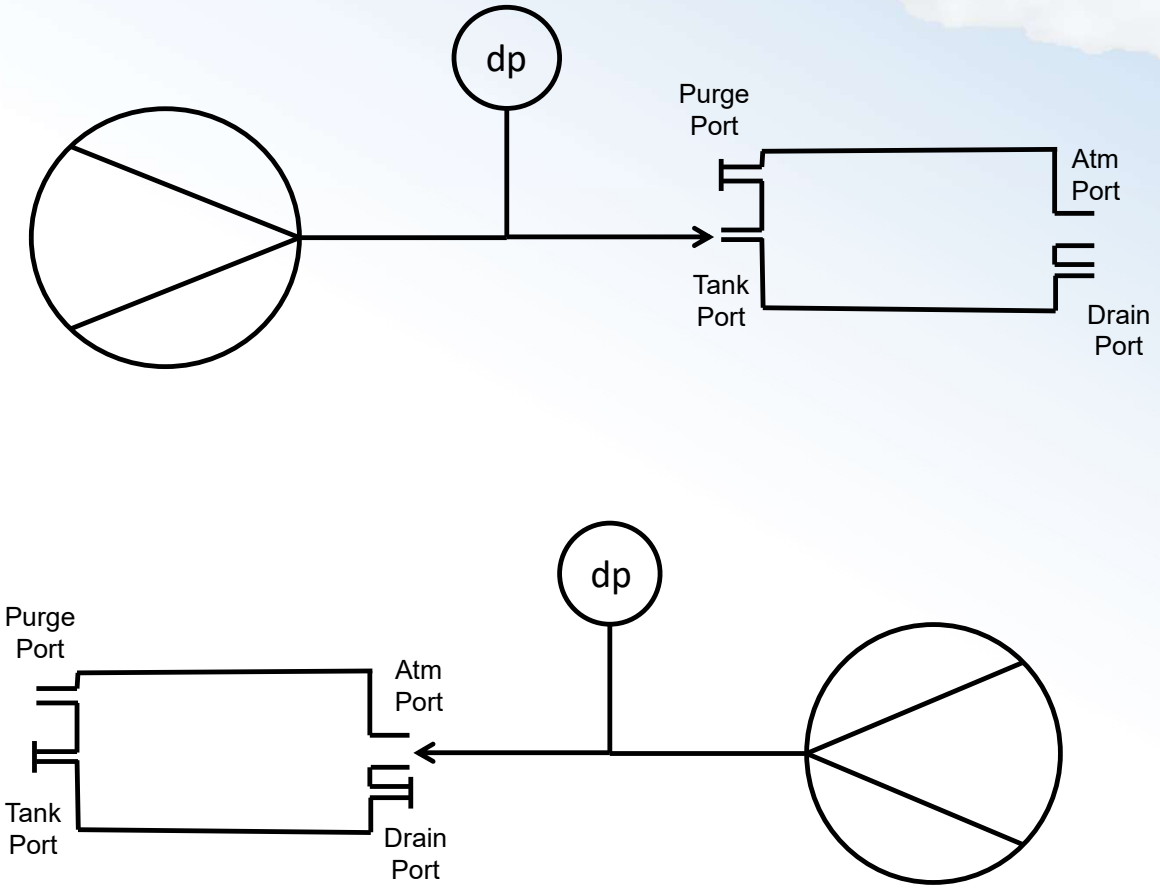
- Allows conversion between weight and volume.
- The dried carbon sample is fed to the graduated cylinder by vibration at a rate of 0.75 to 1.00 ml/second
- The weight of the carbon divided by the volume filled is the apparent density (AD) and is usually expressed as “g/ml” or “kg/l”.



Canister Characteristics

Load/Purge Flow Restriction

- Canisters are subjected to dry, compressed air at a rate of 20 standard liters per minute into the load port and allowed to exit the canister through the atmospheric port, while the differential pressure was monitored. This configuration, with the purge port plugged, simulates canister **loading**.
- Canisters are subjected to dry, compressed air at a rate of 20 standard liters per minute into the atmospheric port and allowed to exit the canister through the purge port, while the differential pressure was monitored. This configuration, with the tank port and drain port plugged, simulates canister **purging**.



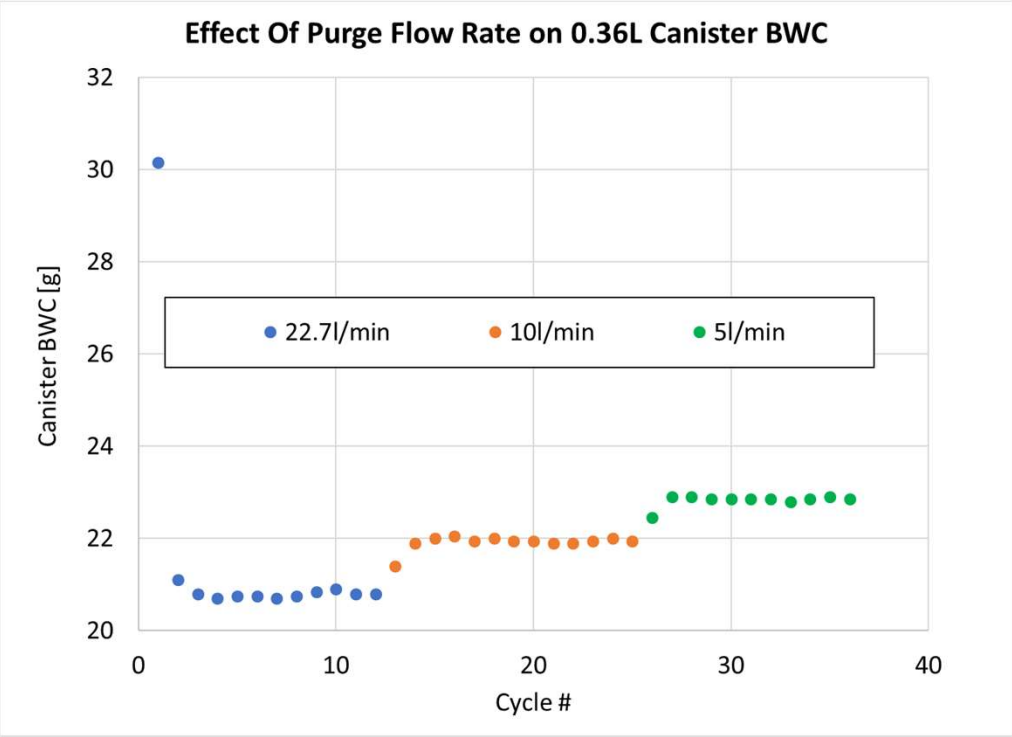
Current Production Canister Design Specifications

Vehicle Year and Manufacturer	2019 Honda	2019 Harley Davidson	2015 Honda	SYM	2018 Suzuki	2020 Triumph EU Production	2020 Triumph US Production	2020 Triumph MECA Prototype
Vehicle Model	Super Cub C125	Street Bob	VT 750	Wolf 300	GSX-R	Street Triple	Street Triple	Street Triple
Engine Displacement [ccm]	125	1750	745	278	1000	765	765	765
Tank Size [l]	3.8	13.2	14.0	14.0	16.0	17.4	17.4	17.4
Carbon Volume [ml]	125	360	570	170	390	260	390	480
Canister Exterior Size incl. ports [ml]	325	920	1150	497	720	662	814	873
Carbon Volume/Canister Size [%]	38%	39%	50%	34%	54%	39%	48%	55%
Canister ID	083-MGH-20	091-MGH-20	042-MGH-21	003-MGH-21	017-MGH-21	097-MGH-20	013-MGH-21	009-MGH-21
Carbon Sample	C200937	C201076	C201215	C201216	C210154	C201100	C210080	C201136
Canister Material	PA6	PA6	Metal	PA6	PA6	PA6	PA6	PLA
Canister Seal	Spin Welded Cover	Vibration Welded Cover	Crimped and Sealed Cover	Spin Welded Cover	Vibration Welded Cover	Spin Welded Cover	Vibration Welded Cover	Glued
Canister weight [g]	107	262	181	120	257	181	310	310
Wall thickness [mm]	1.5	1.5	0.8	1.5	1.5	2	1.5	1.5
Tank Port OD [mm]	5.0	6.0	5.0	5.0	6.6	5.0	9	5.0
Purge Port OD [mm]	8.0	6.0	10.0	10.0	6.6	8.0	9	8.0
Vent Port OD [mm]	10.0	10.0	10.0	10.0	10.0	10.0	10	10.0
Carbon Compression	Fleece	Spring	Spring	Fleece	Spring	Fleece	Spring	Spring
Filters	multi layer fleece	foam	Fleece	Fleece	Fleece	Fleece	Fleece	Foam
Chambers	1	2 (50/50)	1	1	2	1	1	2
Chamber dimension L x A [cm x cm^2]	8.9x13.8	2x13x13.8	9x63	7x23.8	2x10x19.5	10.5x25.5	12.6x30.9	2x12x20
Canister L/D	2.12	6.2	1.0	1.3	4.0	1.8	2.0	4.8
Load Flow Restriction @ 20 l/min [kPa]	3.83	2.32	2.67	5.28	2.60	4.69	4.87	2.29
Purge Flow Restriction @ 20 l/min [kPa]	0.47	2.08	0.85	2.37	2.34	0.89	0.74	1.31

Results Summary of Carbon, BWC, GWC and BETP results

Vehicle Year and Manufacturer	2019 Honda	2019 Harley Davidson	2015 Honda	SYM	2018 Suzuki	2020 Triumph EU Production	2020 Triumph US Production	2020 Triumph MECA Prototype
Vehicle Model	Super Cub C125	Street Bob	VT 750	Wolf 300	GSX-R	Street Triple	Street Triple	Street Triple
Canister BWC (excl. 2g BT) @ 15g/h [g]	5.5	20.8	25	6.6	22.8	13.8	22.2	25.6
BWC/Tank Size [g/l]	**1.45**	**1.58**	**1.79**	**0.47**	**1.43**	**0.79**	**1.28**	**1.47**
Canister GWC (excl. 2g BT) @ 40g/h [g]	6.0	24.1	26.5	7.8	24.6	14.7	23.8	30.1
Carbon ASTM BWC [g/100ml]	12.3	15.4	11.5	11.3	15.6	15.0	10.5	15.0
Carbon Shape	pellet	granular	granular	granular	granular	granular	granular	granular
Carbon weight [g]	53	101	180	48	117	83	180	153.5
Carbon Density dry [g/l]	328	267	286	276	280	262	350	289
BETP 3-day Canister Emissions, 300 BV [mg]	215	276	842	2975	-	1352	464	176
BETP 3-day Canister Emissions, 100 BV [mg]	269	1597	1297	3490	-	3265	555	855
BETP 3-day Aged Canister Emissions, 100 BV [mg]	360	-	-	-	-	-	-	-

Effect of Bench Purge Rate on BWC measured on a Class III motorcycle canister



Canister Butane Working Capacity

Purge Rate [l/min]	BWC [g]
22.7	20.8
10.0	22.0
5.0	22.9

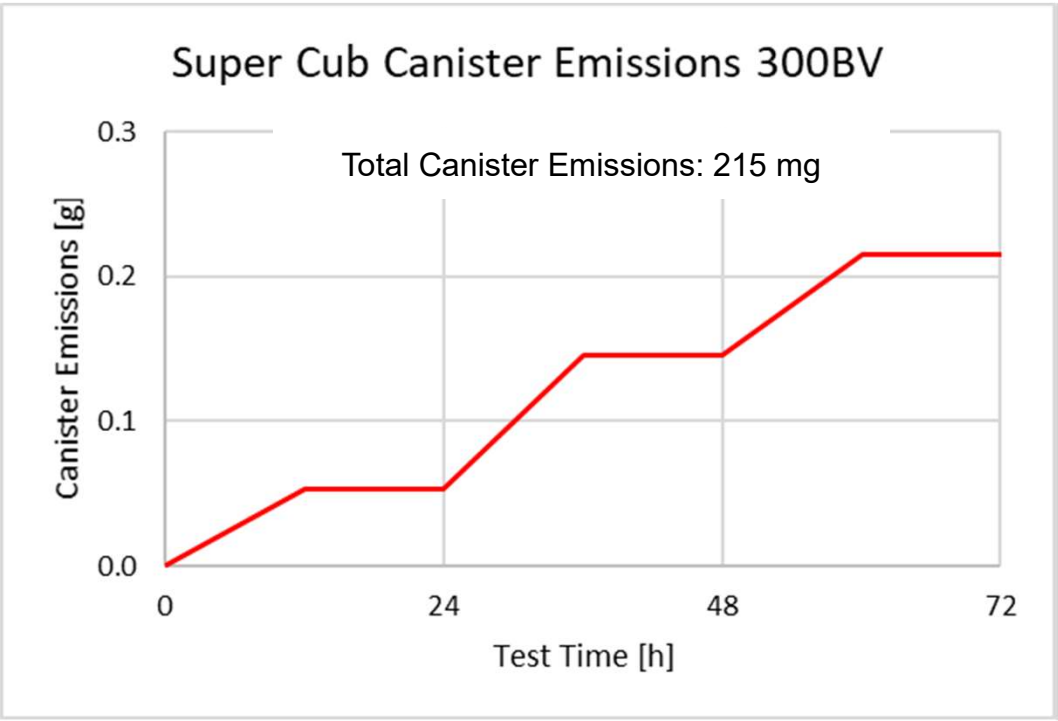
The results indicate that bench purge rate has a significant impact on the measured canister capacity

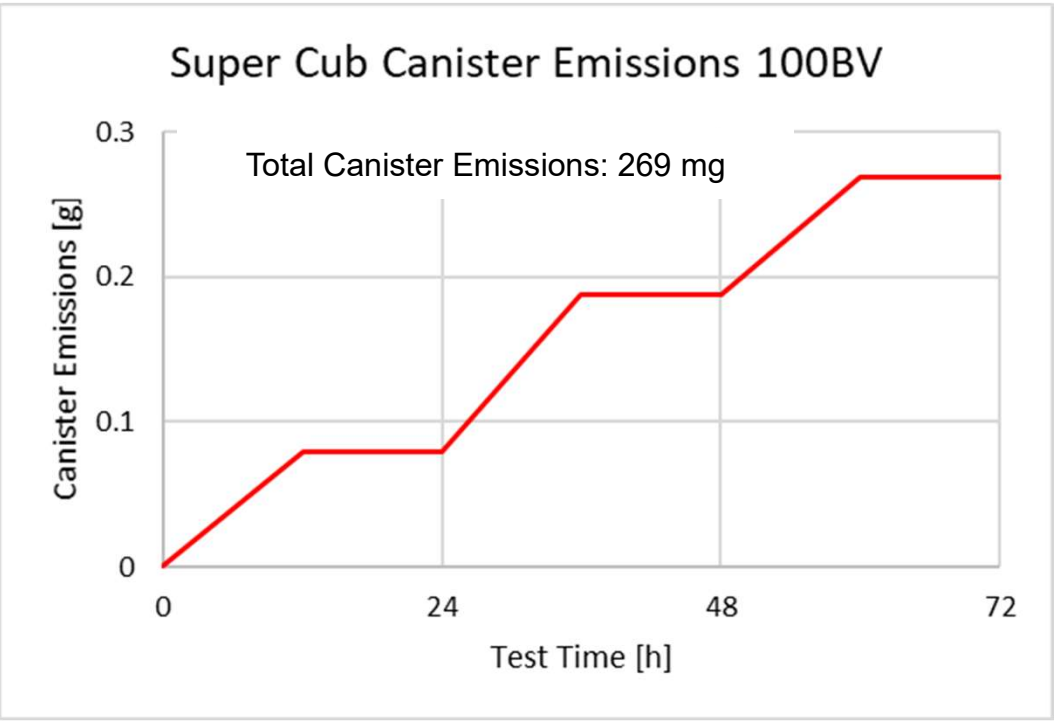
Diurnal Canister Emission Testing Comparison

CARB temp cycle, LEV III fuel, 40% fill, purge rate 10l/min

Purge Volume Comparison- 300BV vs 100BV

- Reduction in purge volume had minimal effect on emissions for this canister due to very low tank vapor generation



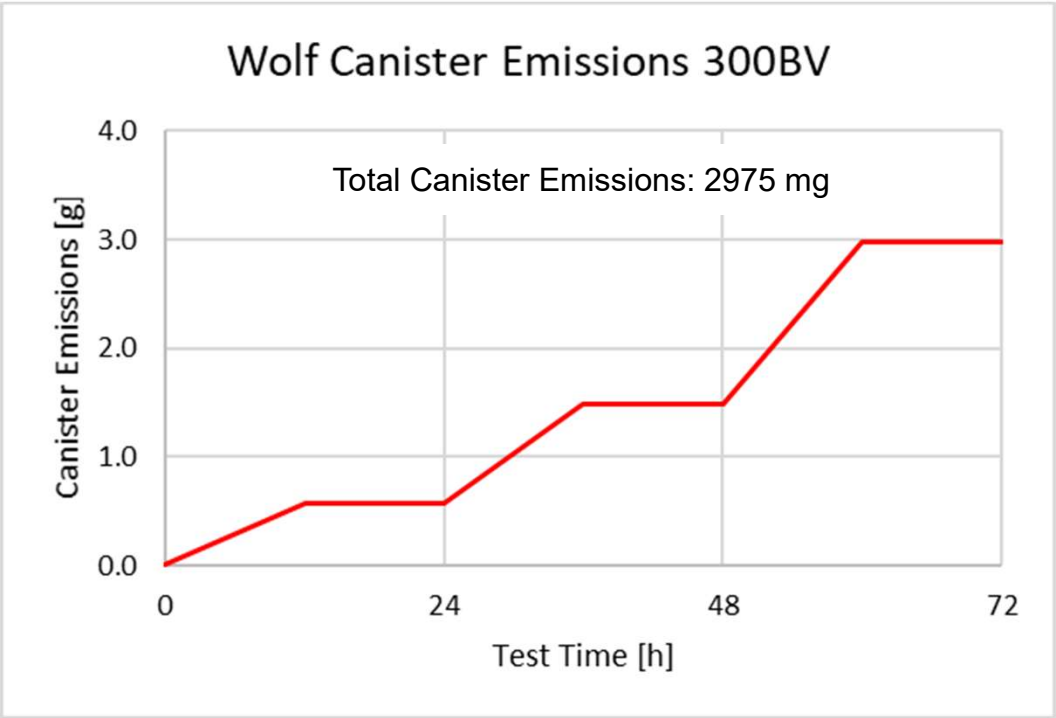


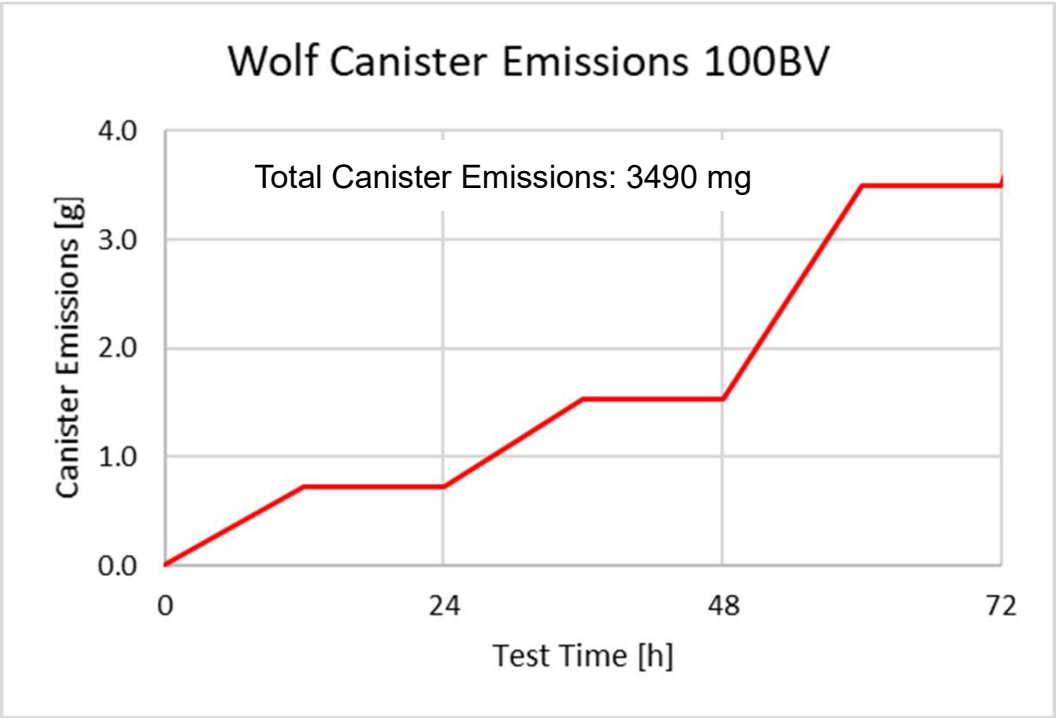
Diurnal Canister Emission Testing Comparison

CARB temp cycle, LEV III fuel, 40% fill, purge rate 10l/min

Purge Volume Comparison- 300BV vs 100BV

- Reduction in purge volume resulted in a slight increase of 17% in cumulative 3-day diurnal canister emissions, even so canister loading was comparatively low



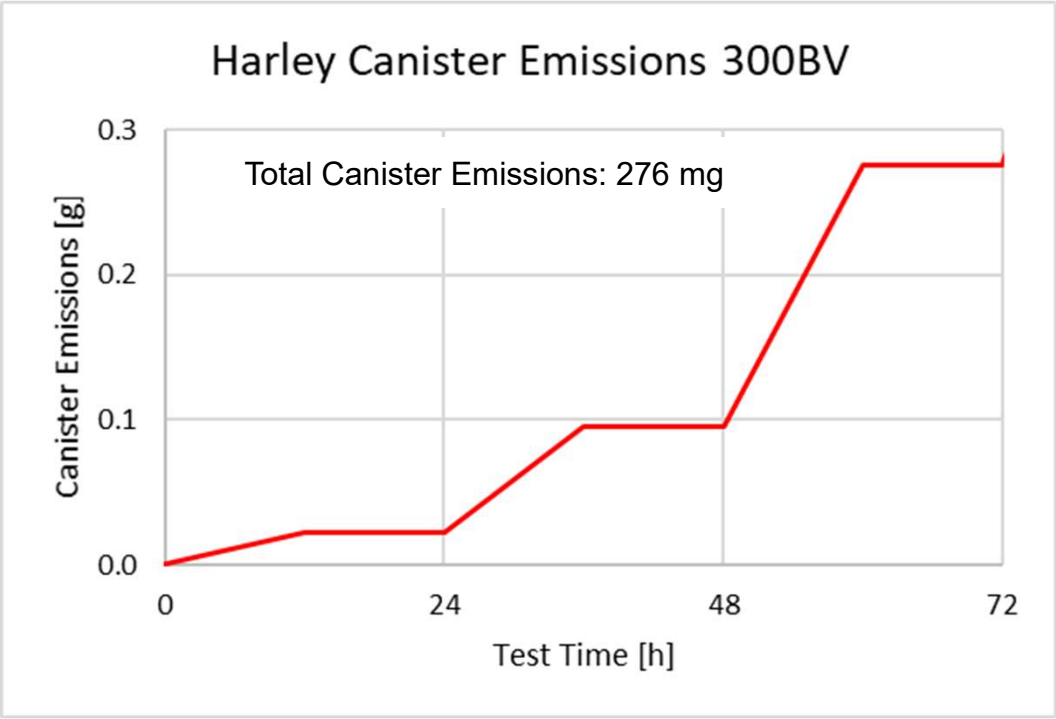


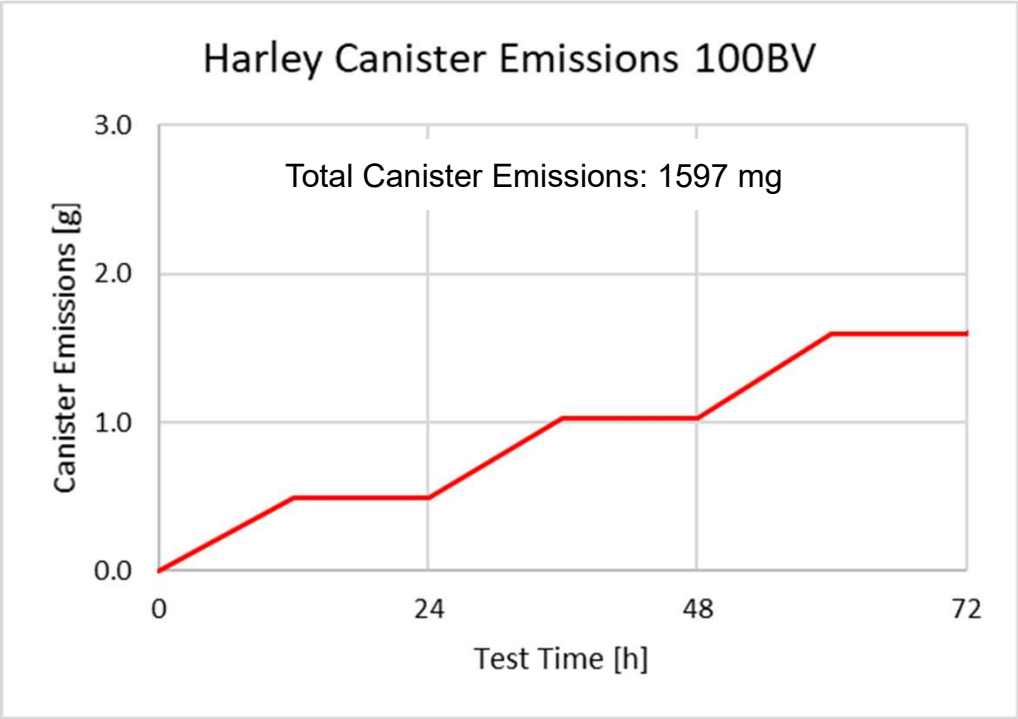
Diurnal Canister Emission Testing Comparison

CARB temp cycle, LEV III fuel, 40% fill, purge rate 10l/min

Purge Volume Comparison- 300BV vs 100BV

- As expected, a reduction in purge volume significantly increased 3-day diurnal canister BETP emissions due to a 20% higher carbon utilization



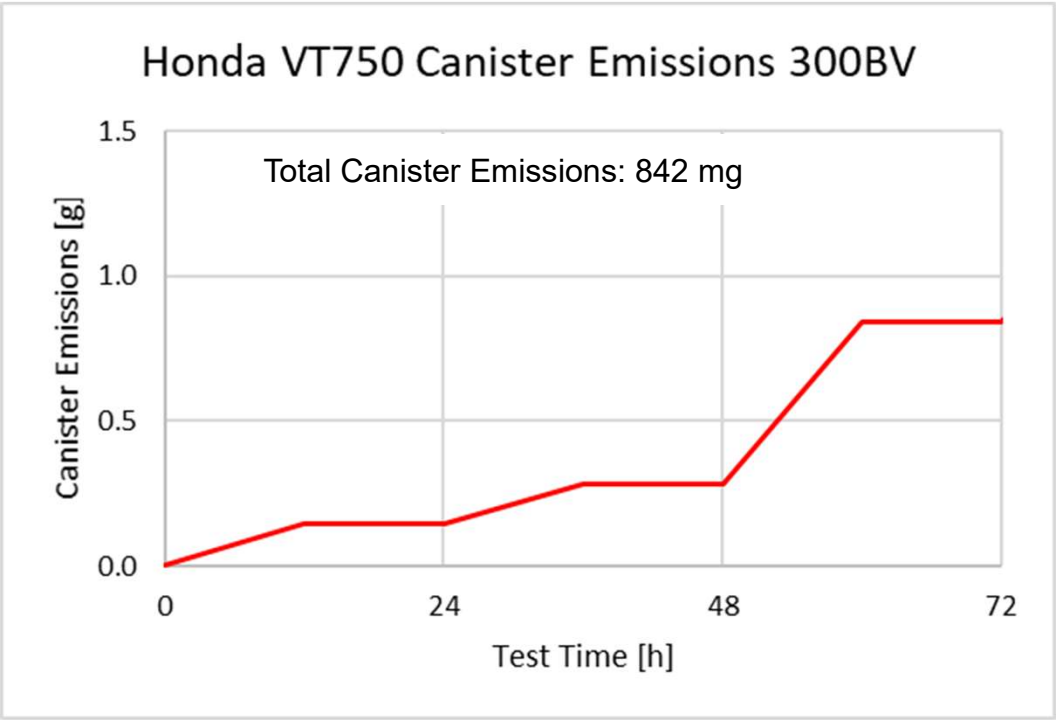


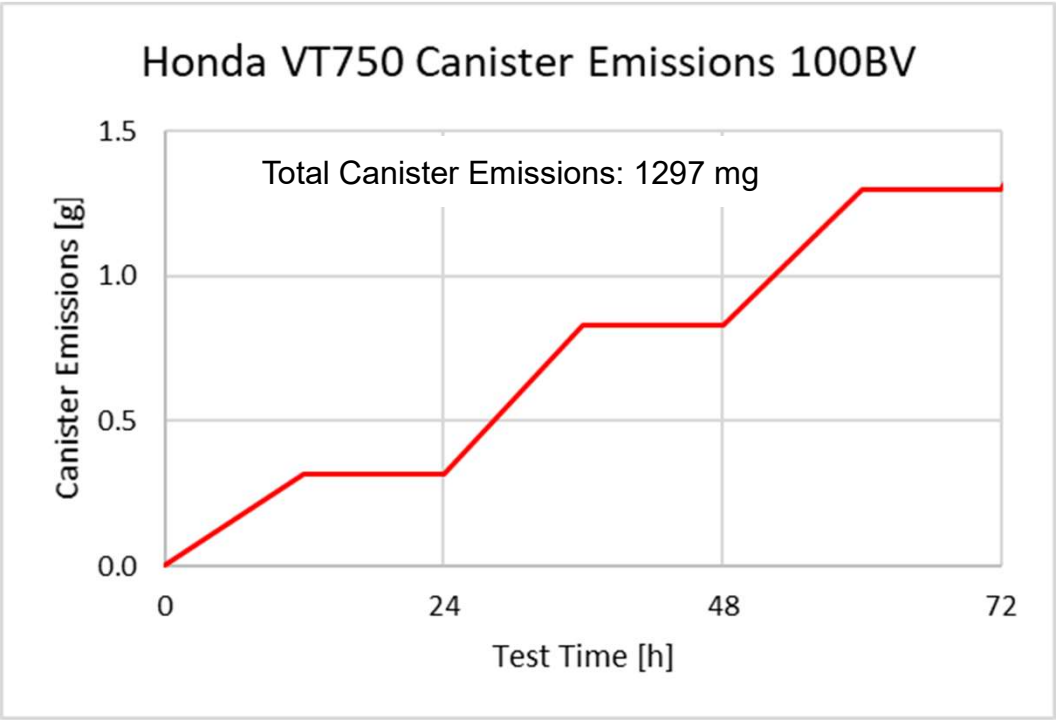
Diurnal Canister Emission Testing Comparison

CARB temp cycle, LEV III fuel, 40% fill (Harley Davidson Tank), purge rate 10l/min

Purge Volume Comparison- 300BV vs 100BV

- Reduction in purge volume significantly increased day 1 and day 2 canister BETP emissions, which resulted in higher total emissions.



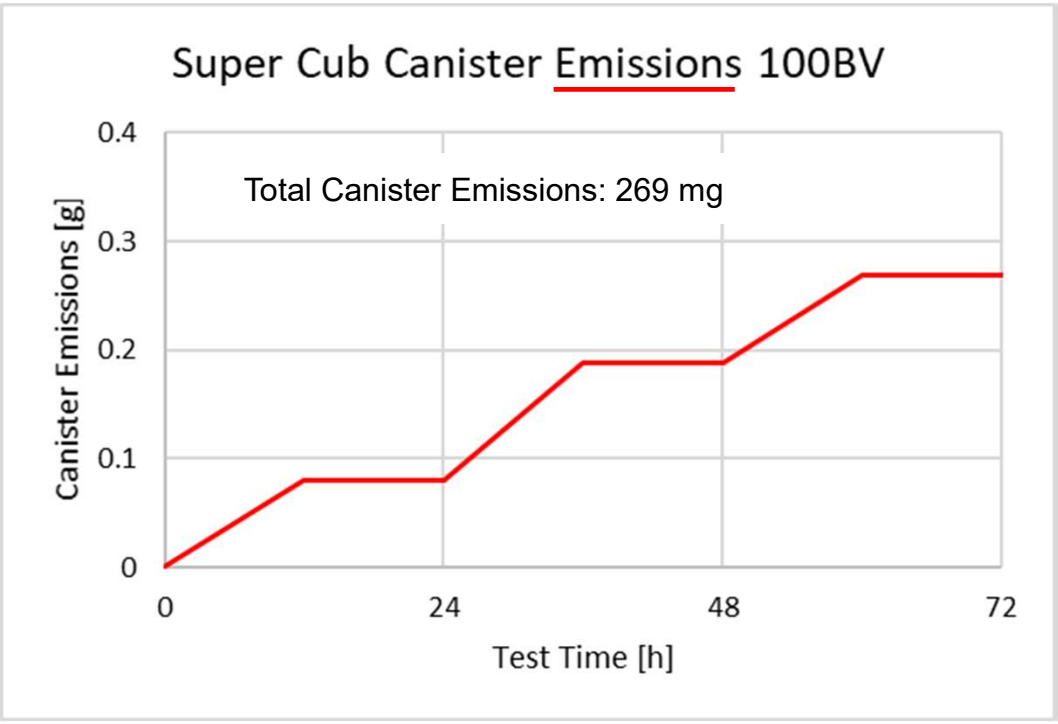


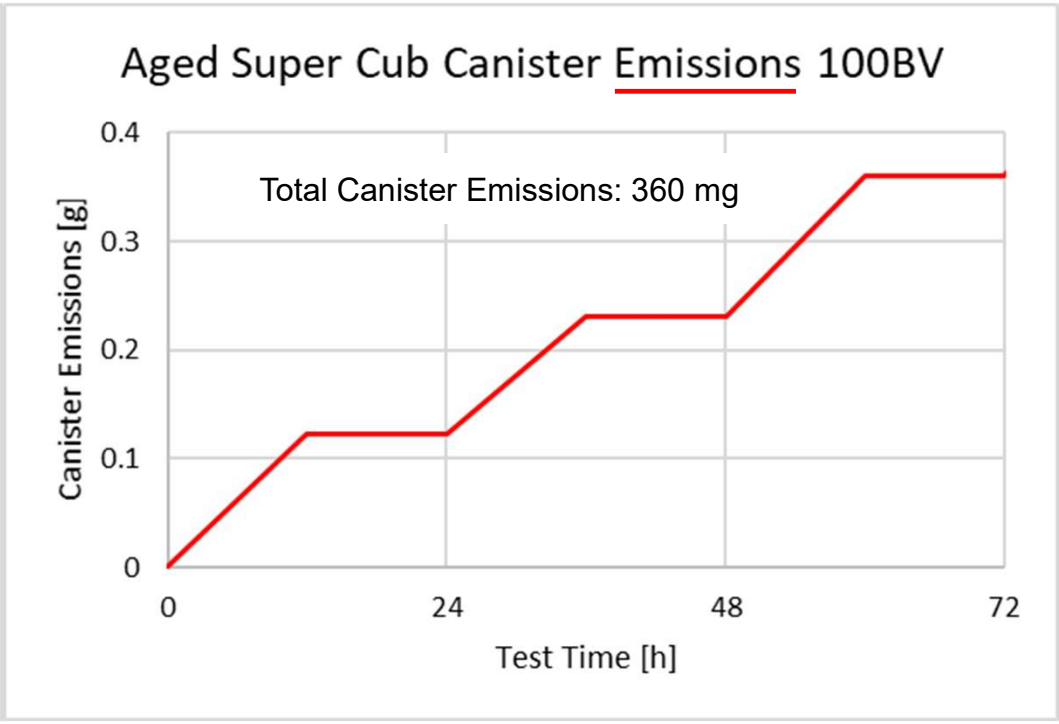
Diurnal Canister Emission Testing Comparison

CARB temp cycle, LEV III fuel, 40% fill, purge rate 10l/min

BETP Results- New vs Aged with 300 GWC cycles

- As expected, aging the canister with 300 GWC cycles resulted in 34% higher 3-day diurnal BETP emissions. The impact of aging on emissions can be minimized by introducing a carbon durability standard.



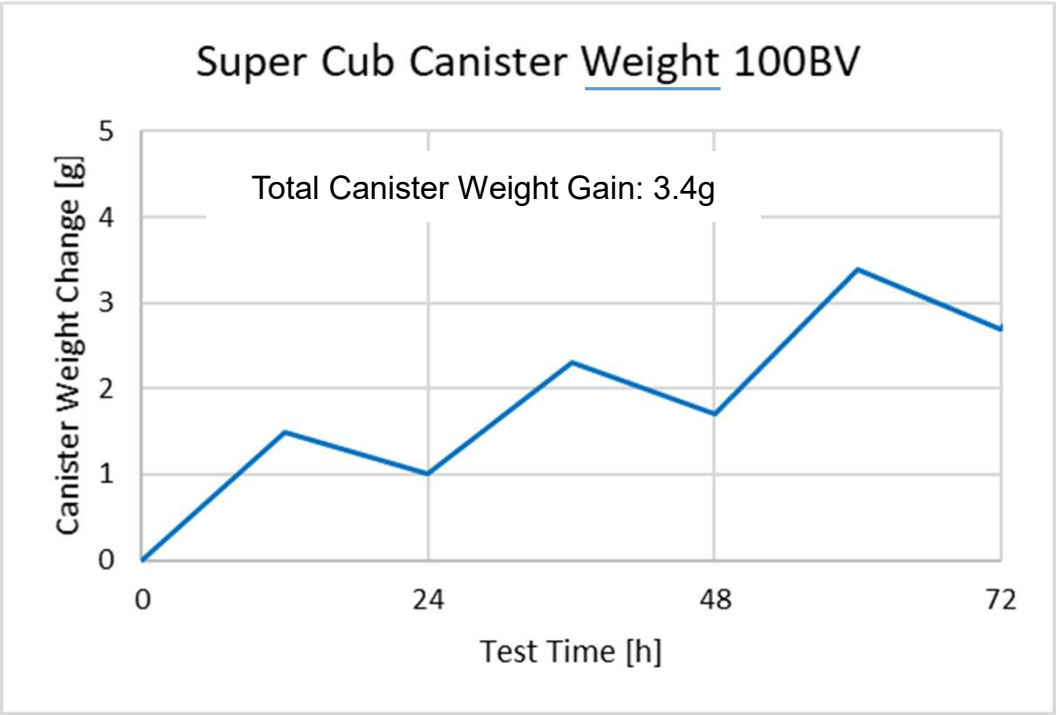


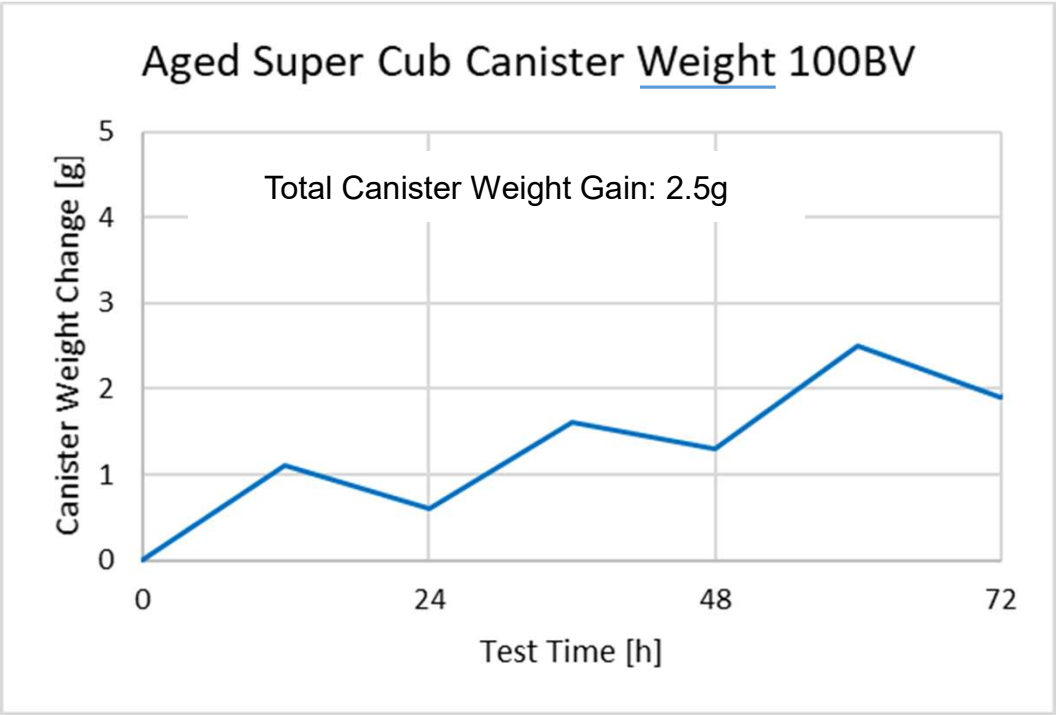
Diurnal Canister Emission Testing Comparison

CARB temp cycle, LEV III fuel, 40% fill, purge rate 10l/min

BETP Results- New vs Aged with 300 GWC cycles

- Aged canister emissions (previous slide) are 34% higher even with test to test variation of 26% less canister loading
- Canister emissions are expected to be higher with equivalent canister loading



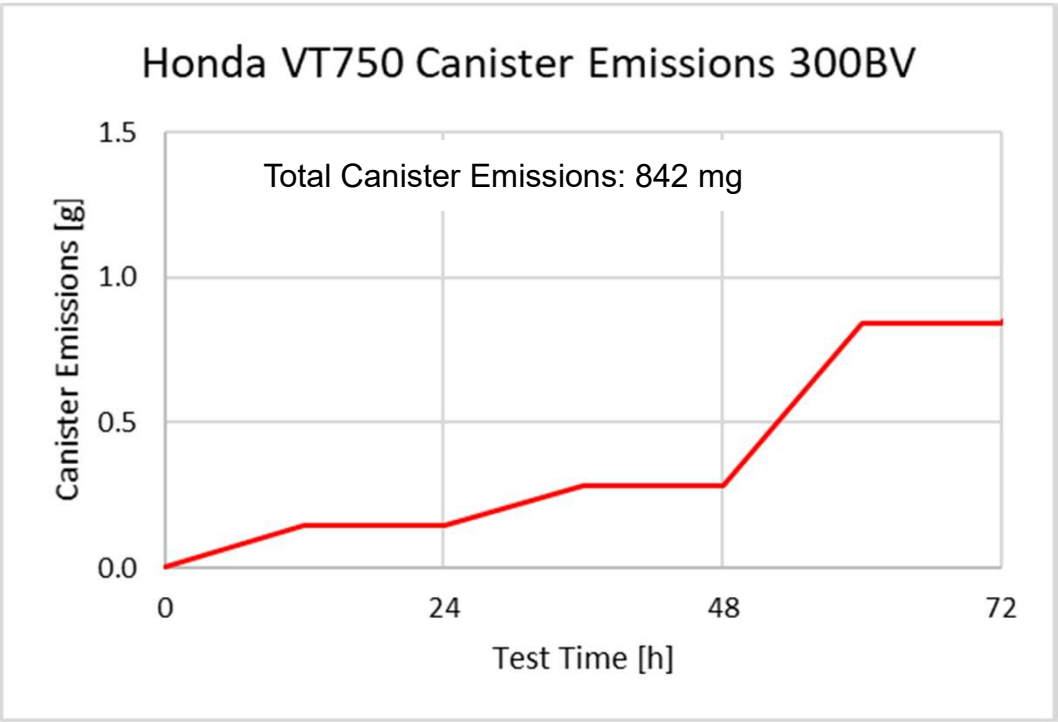


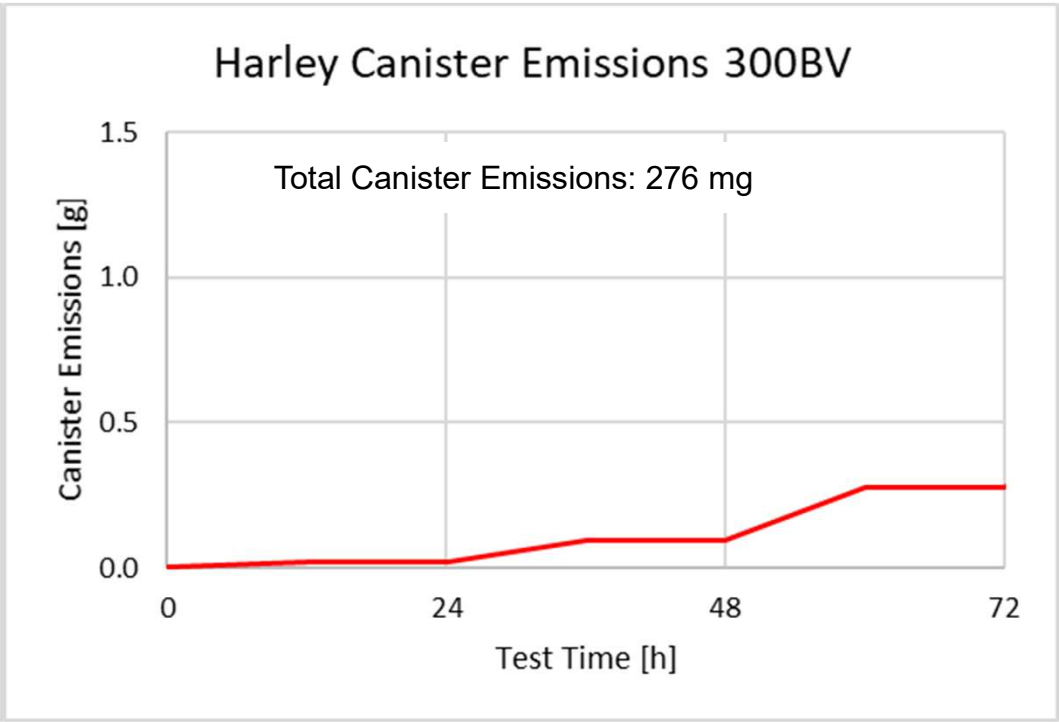
Diurnal Canister Emission Testing Comparison

CARB temp cycle, LEV III fuel, 40% fill (Harley Davidson Tank), purge rate 10l/min

Emission Comparison - Honda VT750 / HD Street Bob

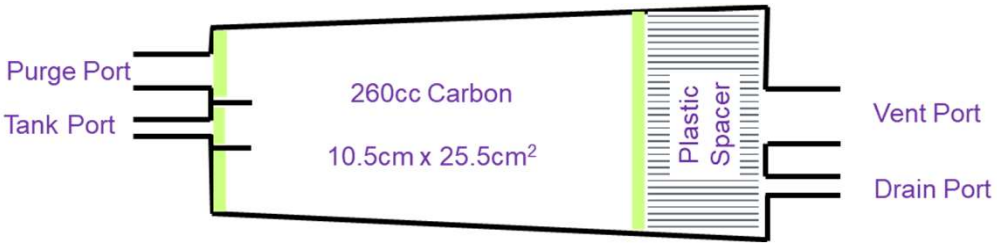
- The Harley had 68% lower emissions than the VT750, even though the VT750 had a canister with a higher GWC and BWC because the Harley's dual chamber design resulted in a canister length to diameter ratio that is six times larger. The larger L/D ratio allows for more efficient adsorption of gasoline vapors.



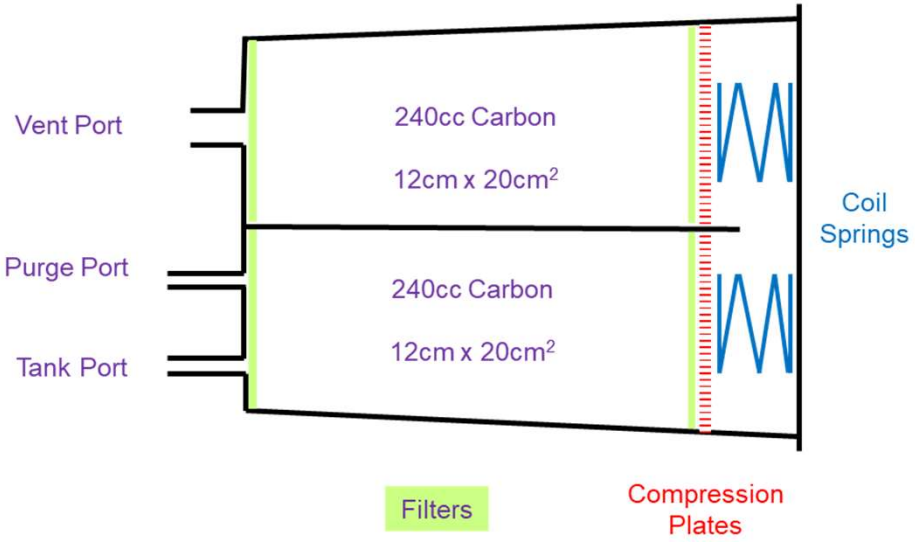


Prototype Canister Design

2020 Triumph Street Triple



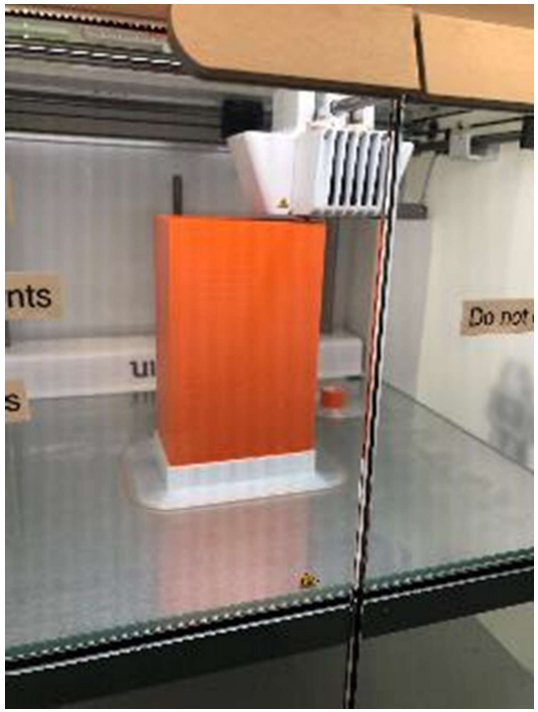
Current EU Canister Design

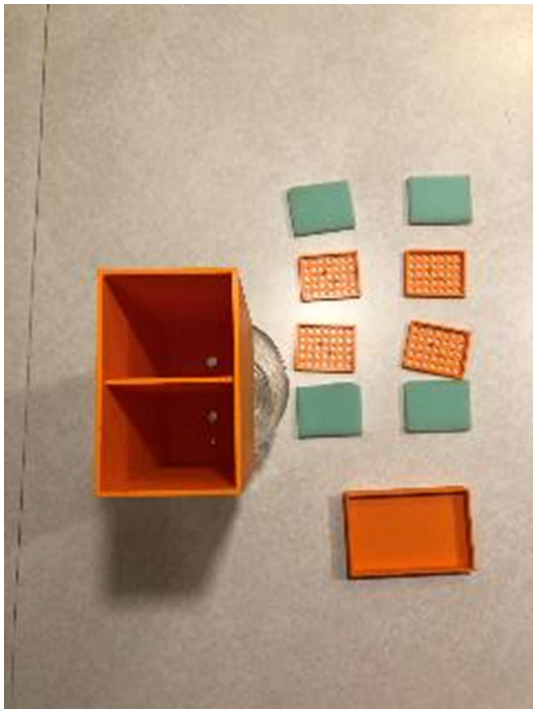


Prototype Canister Design

Prototype Canister Design

2020 Triumph Street Triple – 3d Printing of Prototype Canister





Prototype Canister Design

EU vs US vs Prototype Canisters for the 2020 Triumph Street Triple

EU Production

US Production

Prototype

Current Production vs. Prototype Canister Comparison

2020 Triumph Street Triple

Vehicle Year and Manufacturer	2020 Triumph EU Production	2020 Triumph US Production	2020 Triumph MECA Prototype
Vehicle Model	Street Triple	Street Triple	Street Triple
Engine Displacement [ccm]	765	765	765
Tank Size [l]	17.4	17.4	17.4
Carbon Volume [ml]	260 →	390 →	480
Canister Exterior Size incl. ports [ml]	662	814	873
Carbon Volume/Canister Size [%]	39%	48%	55%
Canister ID	097-MGH-20	013-MGH-21	009-MGH-21
Carbon Sample	C201100	C210080	C201136
Canister Material	PA6	PA6	PLA
Canister Seal	Spin Welded Cover	Vibration Welded Cover	Glued
Canister weight [g]	181	310	TBD
Wall thickness [mm]	2	1.5	1.5
Tank Port OD [mm]	5.0	9	5.0
Purge Port OD [mm]	8.0	9	8.0
Vent Port OD [mm]	10.0	10	10.0
Carbon Compression	Fleece	Spring	Spring
Filters	Fleece	Fleece	Foam
Chambers	1	1	2
Chamber dimension L x A [cm x cm^2]	10.5x25.5	12.6x30.9	2x12x20
Canister L/D	1.8 →	2.0 →	4.8
Load Flow Restriction @ 20 l/min [kPa]	4.69	4.87	2.29
Purge Flow Restriction @ 20 l/min [kPa]	0.89	0.74	1.31

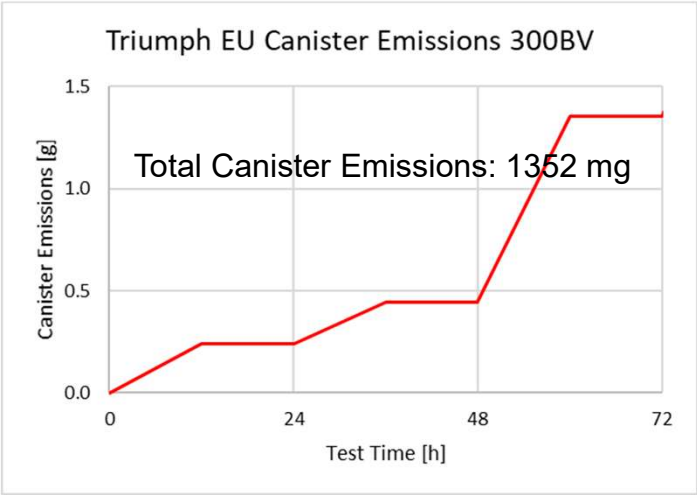
Vehicle Year and Manufacturer	2020 Triumph EU Production	2020 Triumph US Production	2020 Triumph MECA Prototype
Vehicle Model	Street Triple	Street Triple	Street Triple
Canister BWC (excl. 2g BT) @ 15g/h [g]	13.8	22.2	25.6
BWC/Tank Size [g/l]	**0.79** →	**1.28** →	**1.47**
Canister GWC (excl. 2g BT) @ 40g/h [g]	14.7	23.8	30.1
Carbon ASTM BWC [g/100ml]	15.0	10.5	15.0
Carbon Shape	granular	granular	granular
Carbon weight [g]	83	180	153.5
Carbon Density wet [g/l]	319	462	320
Carbon Density dry [g/l]	262	350	289
BETP 3-day Canister Emissions, 300 BV [mg]	1352 →	464 →	176
BETP 3-day Canister Emissions, 100 BV [mg]	3265	555	855
BETP 3-day Aged Canister Emissions, 100 BV [mg]	-	-	-

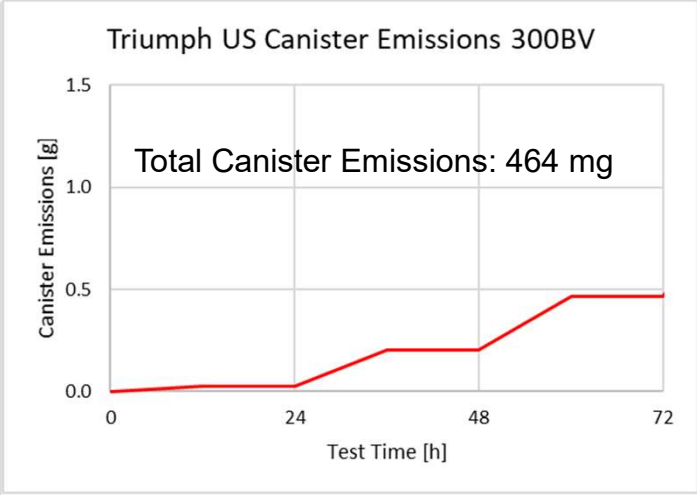
Diurnal Canister Emission Testing Comparison

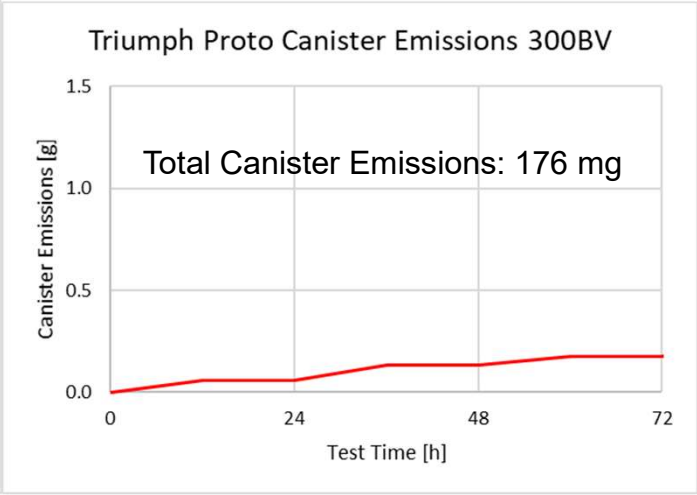
CARB temp cycle, LEV III fuel, 40% fill, purge rate 10l/min

Triumph Street Triple Canister Volume Comparison

- The US canister design reduced emissions by 66% compared to the EU canister design due to a 1.5 times larger carbon canister volume which yielded 1.6 times higher BWC and GWC.
- Replacing the EU design with the prototype canister reduced 3-day cumulative diurnal BETP emissions by 87% due to the 1.8 times higher carbon canister volume, 1.9 times higher BWC and 2.0 times higher GWC and 2.7 times higher length/diameter (L/D) ratio





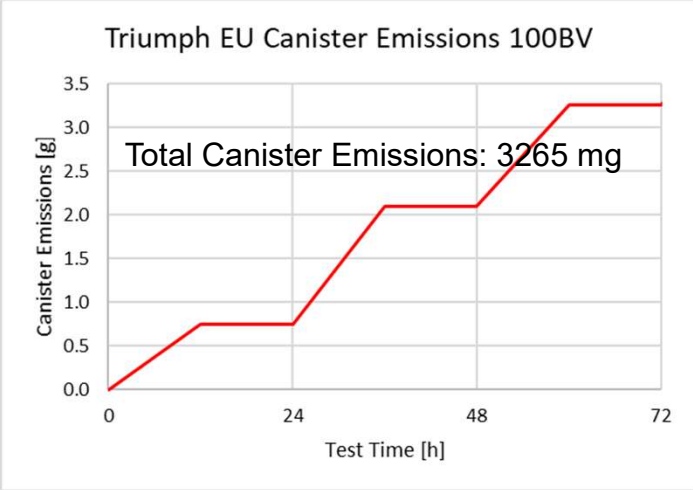


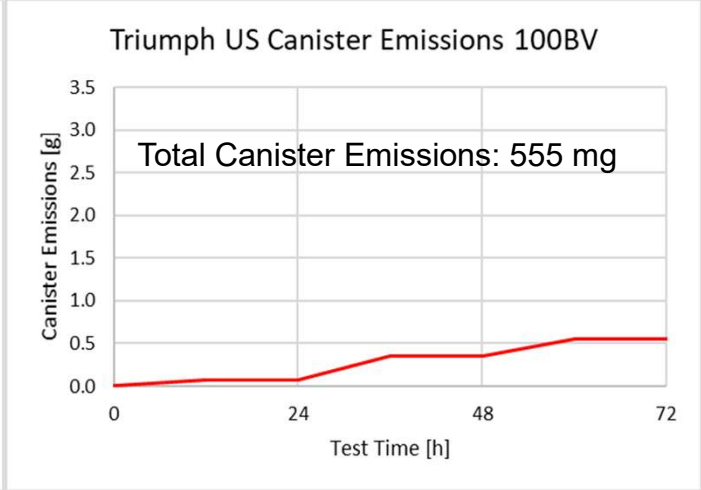
Diurnal Canister Emission Testing Comparison

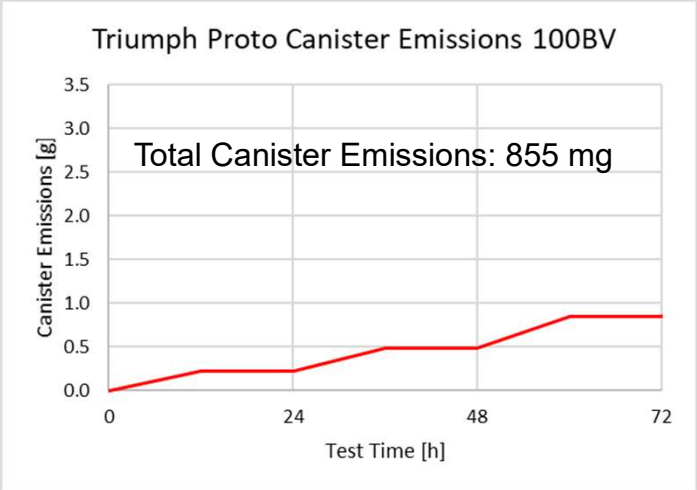
CARB temp cycle, LEV III fuel, 40% fill, purge rate 10l/min

Triumph Street Triple Canister Volume Comparison

- The US and Prototype canister designs maintained significant emissions reductions of 73 to 83% compared to the EU canister design at 100 bed volumes of purge
- Time only allowed a single test with no repeats so the results reflect test-to-test variations







Observations and Recommendations

- Elements for canister improvements were identified for several motorcycles whose canisters had evaporative emission greater than 1g/day.
  - It was found that increasing the carbon capacity (higher g/L of BWC/fuel tank), improving carbon quality (use of carbon with higher BWC and enhanced durability), and increasing the canister length:diameter (L/D) ratio (multiple vs. single chamber design) resulted in the largest reduction in diurnal canister emissions for motorcycles with the largest fuel tanks.

- BETP observations:
  - Improving the canister design ensures diurnal canister emissions can be significantly reduced to less than 1 g/day, even at 100 bed volumes of purge.
  - Replacing the OEM canister with a prototype design reduced diurnal canister bleed emissions for one of the highest emitting bikes by >70%
  - Leak testing performed prior to BETP tests found that some parts assemblies had leaks from fuel caps, tank seals, etc. These leaks were sealed prior to performing BETP tests

- MECA provided data in combination with CARB and EPA SHED test results, revealed that motorcycles with high evaporative levels showed a likelihood of evaporative emission leaks which needed additional design improvements, other than improved canisters, to meet the evaporative goal of 1g/day.

- In addition to a canister design standard, MECA believes that adding a BETP standard, a complete fuel system leak test standard, and a carbon and canister durability standard will ensure evaporative emissions remain below 1g/day for the full useful life of a motorcycle.

- Although this test program did not address hot soak emissions, a comprehensive evaporative emissions standard needs to account for emissions generated not only from the 3-day diurnal test but also those that occur during the hot soak phase of the FTP

Appendix

Canister Overview and Component Analyses

Current Production Canister Evaluation

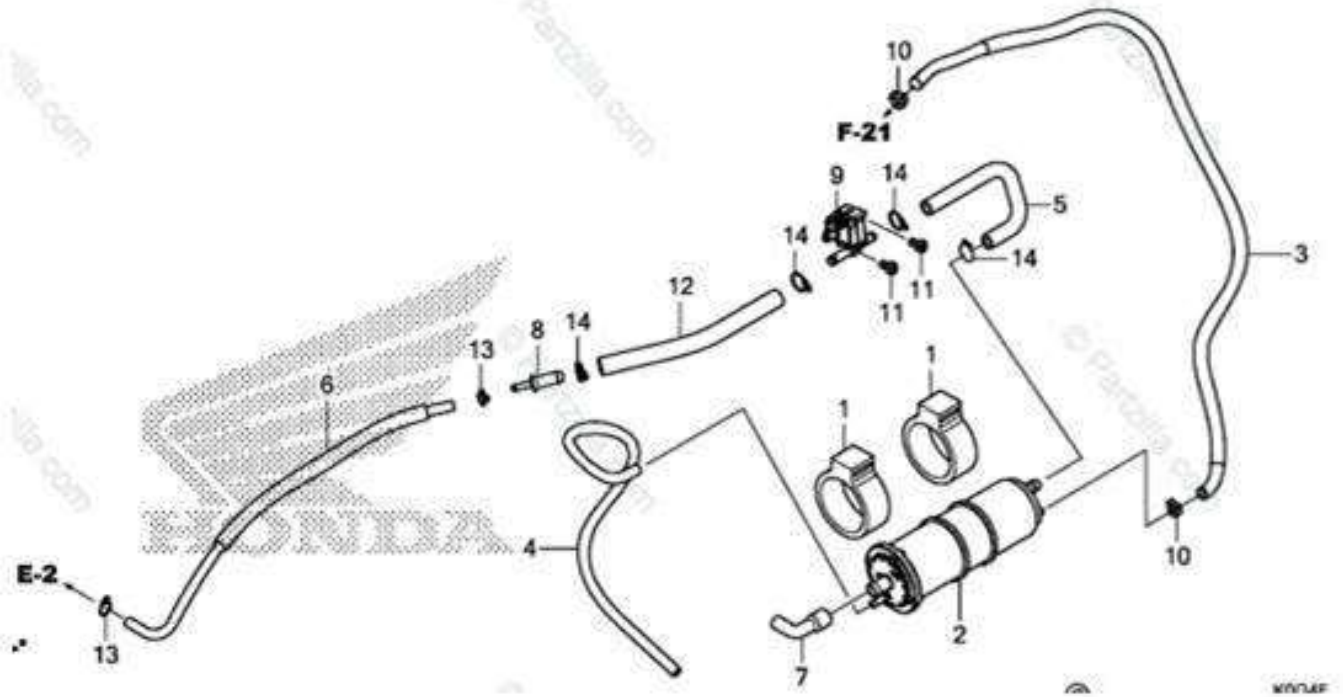
2019 Honda Super Cub C125

Fuel Tank Volume: 3.8L

Canister Carbon Volume: 0.125L

Current Production Canister Evaluation

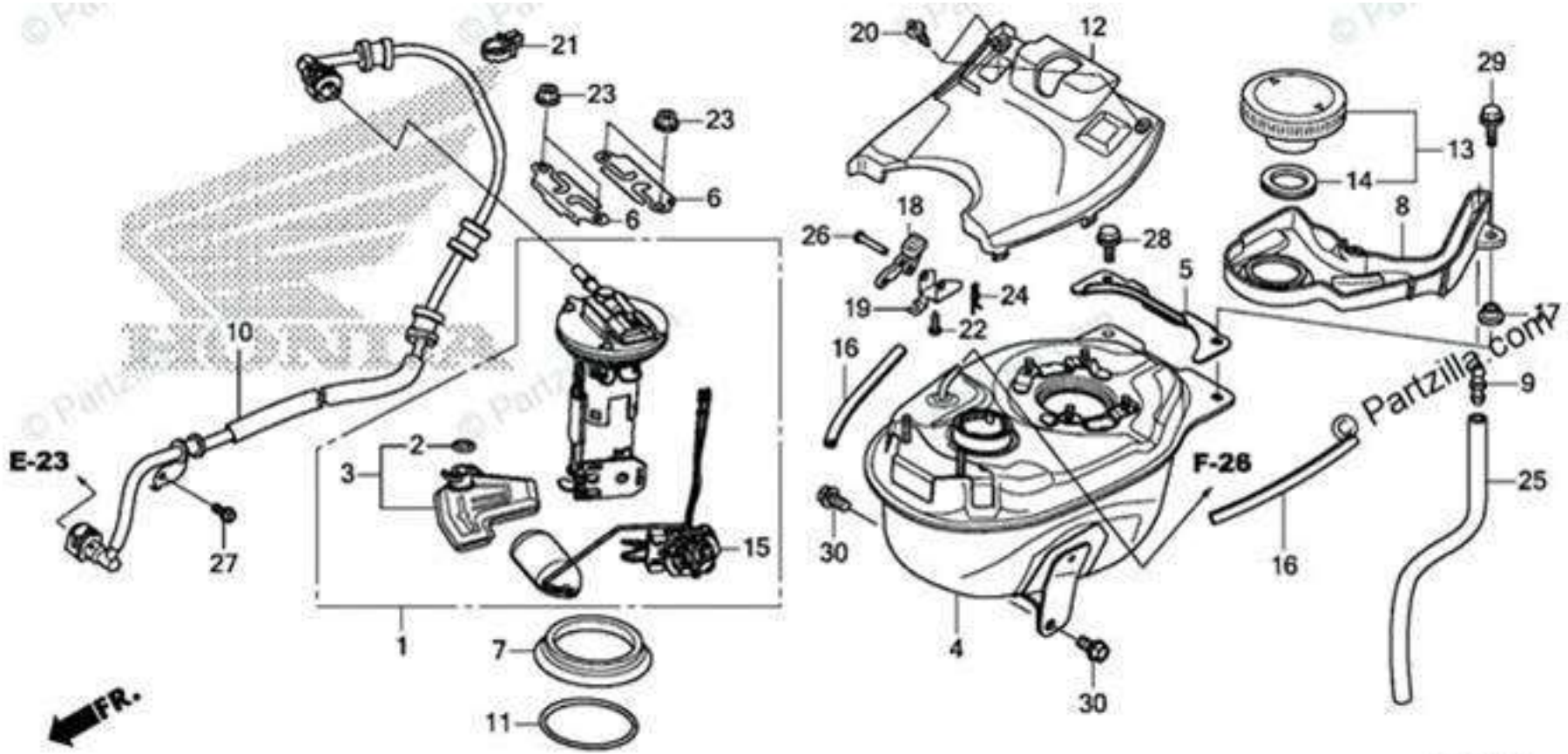
2019 Honda Super Cub C125



001	RUBBER, CANISTER MOUNTING 17311-GPM-K00
002	CANISTER 17410-GPM-K01
003	TUBE, CHARGE 17411-K0G-960
004	TUBE, DRAIN 17412-K0G-900
005	TUBE A, PURGE 17414-K0G-900
006	TUBE B, PURGE 17415-K0G-900
007	TUBE, AIR 17416-K0G-900
008	JOINT, TUBE 19126-KM1-010
009	VALVE, PURGE CONTROL SOLENOID 36162-KZL-931
010	CLAMP, TUBE (8.0) 90652-KSJ-A21 In Stock
011	SCREW, PAN (5X10) 93500-05010-0H In Stock
012	BULK HOSE, FUEL (7.5X8000) OEM CUT SIZE: (7.3X150) 95001-75008-80M In Stock
013	CLIP, TUBE (B7) 95002-02070 In Stock
014	CLIP, TUBE (B12.5) 95002-02130 In Stock

Current Production Canister Evaluation

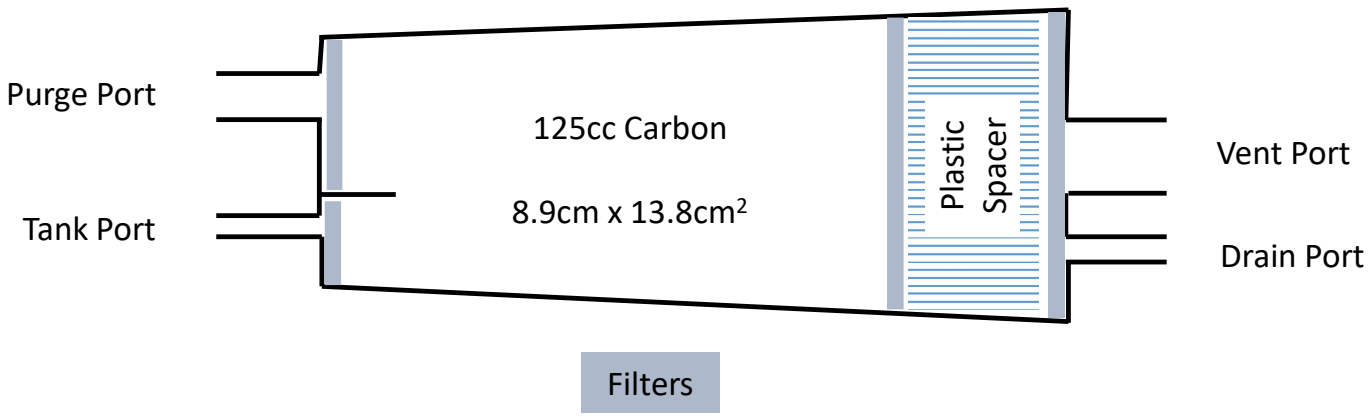
2019 Honda Super Cub C125 - Tank



Current Production Canister Evaluation

2019 Honda Super Cub C125

Canister Schematic



Current Production Canister Evaluation

2019 Honda Super Cub C125

Canister Port Sizes

Purge Port

Tank Port

Vent Port

Drain Port

Current Production Canister Evaluation

2019 Honda Super Cub C125

Canister Vent Side Filtration with Plastic Spacer

Current Production Canister Evaluation

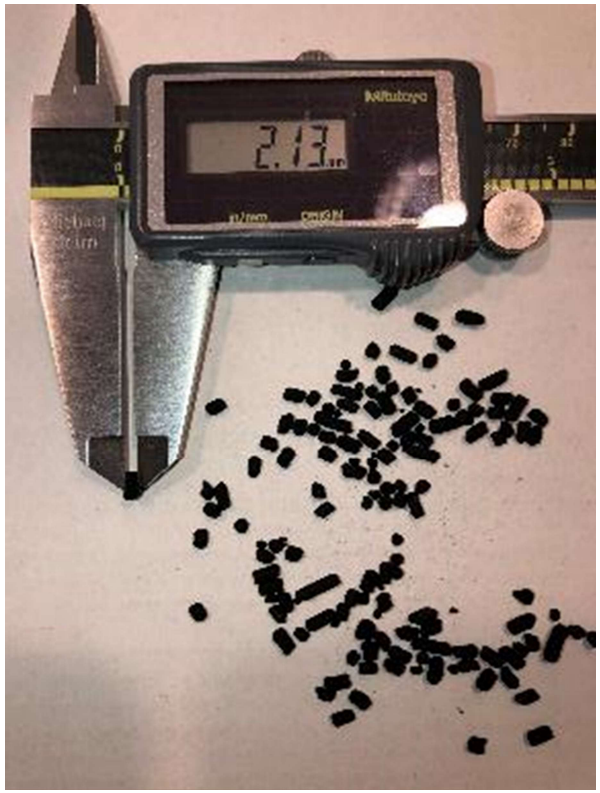
2019 Honda Super Cub C125

Canister Load/Purge Side Filtration

Current Production Canister Evaluation

2019 Honda Super Cub C125

Activated Carbon Weight and Shape

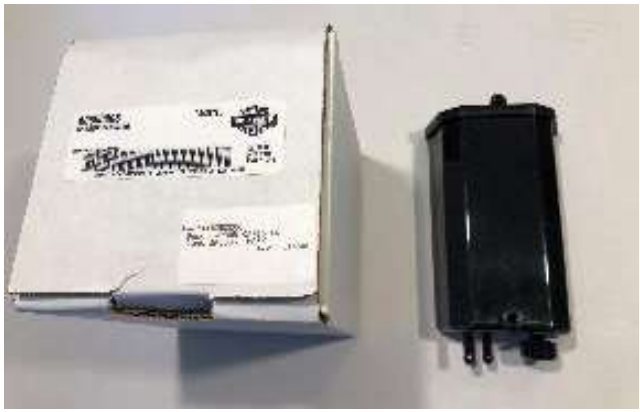


Current Production Canister Evaluation

2019 Harley Davidson Street Bob

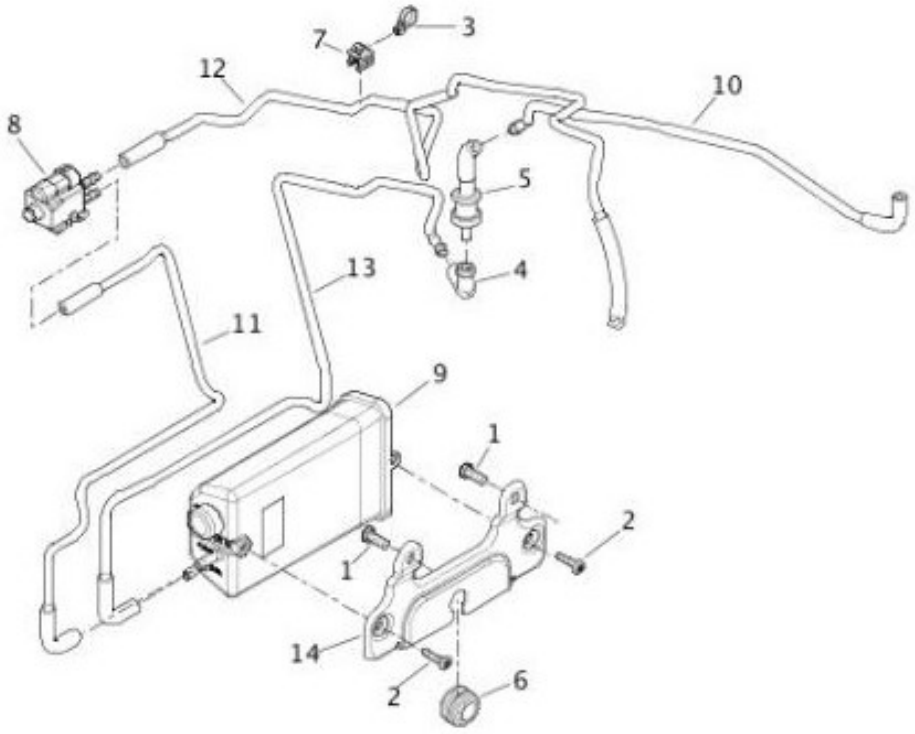
Fuel Tank Volume: 13.2L

Canister Carbon Volume: 0.36L



Current Production Canister Evaluation

2019 Harley Davidson Street Bob

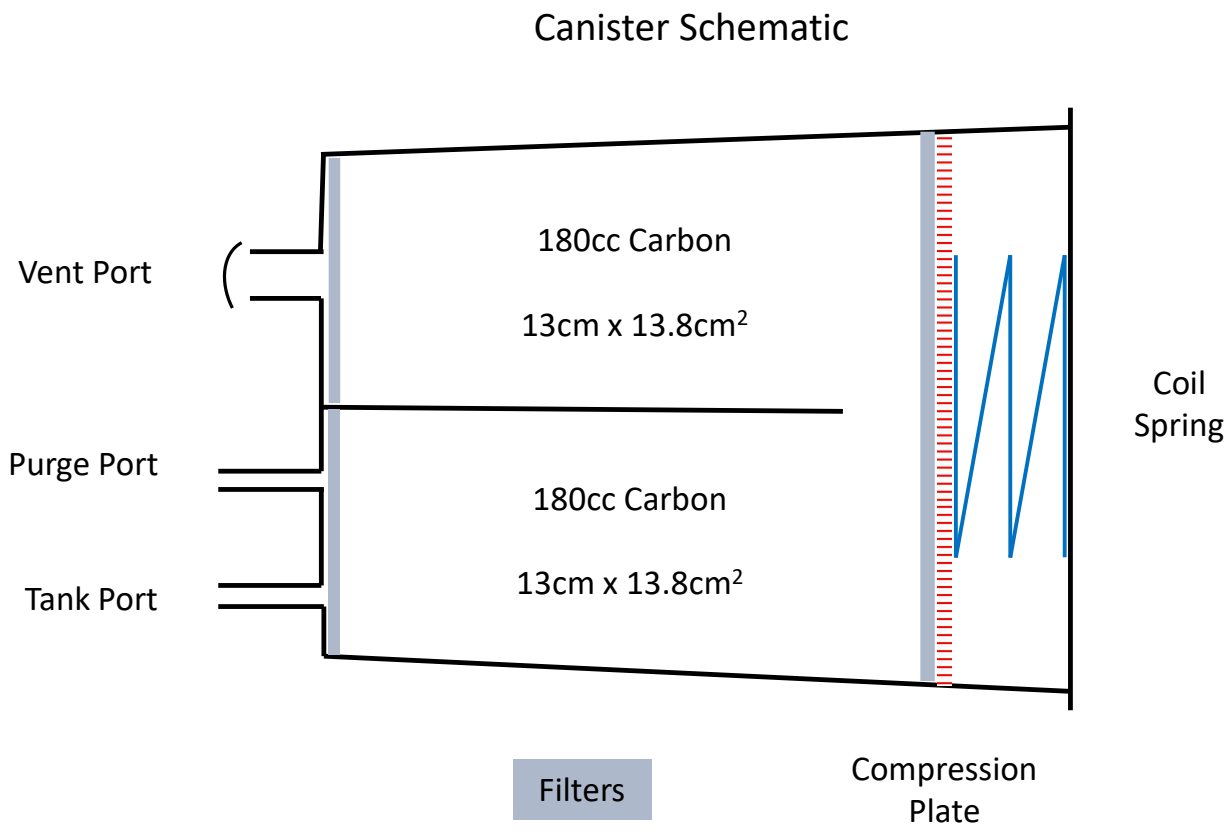


INDEX NO.	PART NO.	DESCRIPTION	MODEL(S)
1	1062	SCREW (2)	ALL
2	4612	SCREW (2)	ALL
3	10006	CABLE STRAP	ALL
4	27250-96B	CONNECTOR, 90 degree elbow	ALL
5	62150-85	VALVE, vapor	ALL
6	12100118	GROMMET	ALL
7	12600214	FASTENER, anchored, vapor valve	ALL
8	31400106	PURGE SOLENOID	ALL
9	60800006	CARBON CANISTER ASSEMBLY	ALL
10	60800035	LINE, evaporative (EVAP), tank to valve	ALL
11	60800036	LINE, evaporative (EVAP), canister to purge solenoid	ALL
12	60800037	LINE, evaporative (EVAP), purge solenoid to induction module	ALL
13	60800044	LINE, evaporative (EVAP), valve to canister, with 27250-96B	ALL
14	60900040	BRACKET	ALL

These parts are required for motorcycles sold in ASEAN, Asia-Pacific, Brazil, California, China, England, HDI, Japan and India markets.

Current Production Canister Evaluation

2019 Harley Davidson Street Bob



Current Production Canister Evaluation

2019 Harley Davidson Street Bob

Canister Port Sizes

Purge Port

Tank Port

Vent Port

Current Production Canister Evaluation

2019 Harley Davidson Street Bob

Canister Geometry

Current Production Canister Evaluation

2019 Harley Davidson Street Bob

Carbon Bed Compression

Current Production Canister Evaluation

2019 Harley Davidson Street Bob

Canister Components

Current Production Canister Evaluation

2019 Harley Davidson Street Bob

Activated Carbon Weight and Shape

Current Production Canister Evaluation

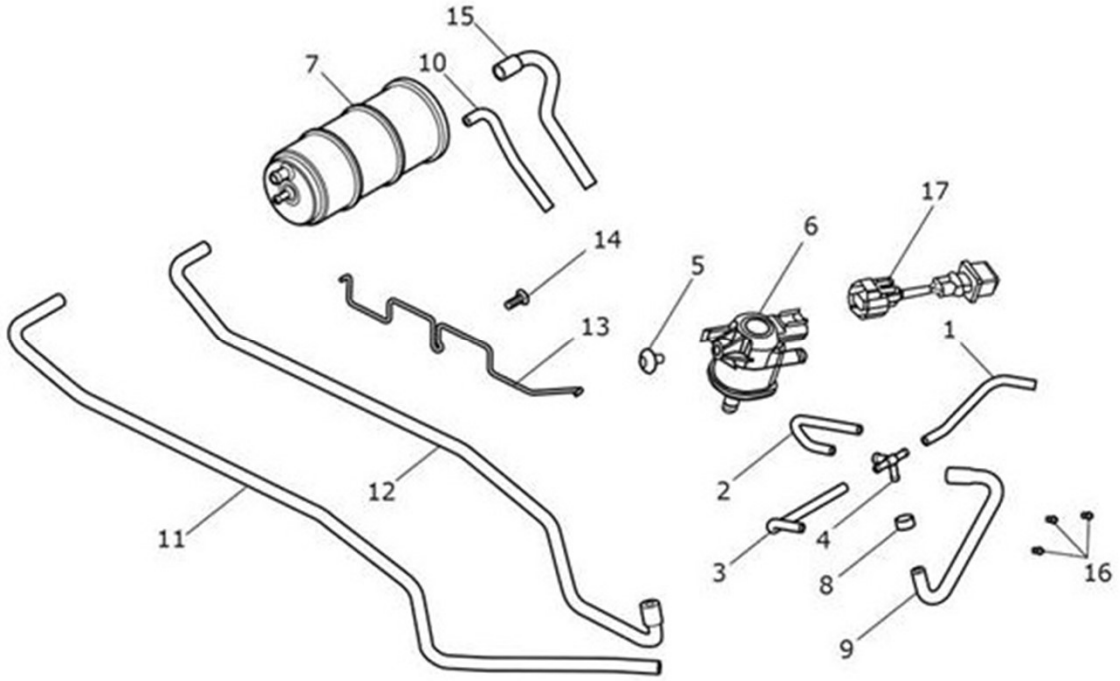
2020 Triumph Street Triple

Fuel Tank Volume: 17.4L

Canister Carbon Volume: 0.26L

Current Production Canister Evaluation

2020 Triumph Street Triple

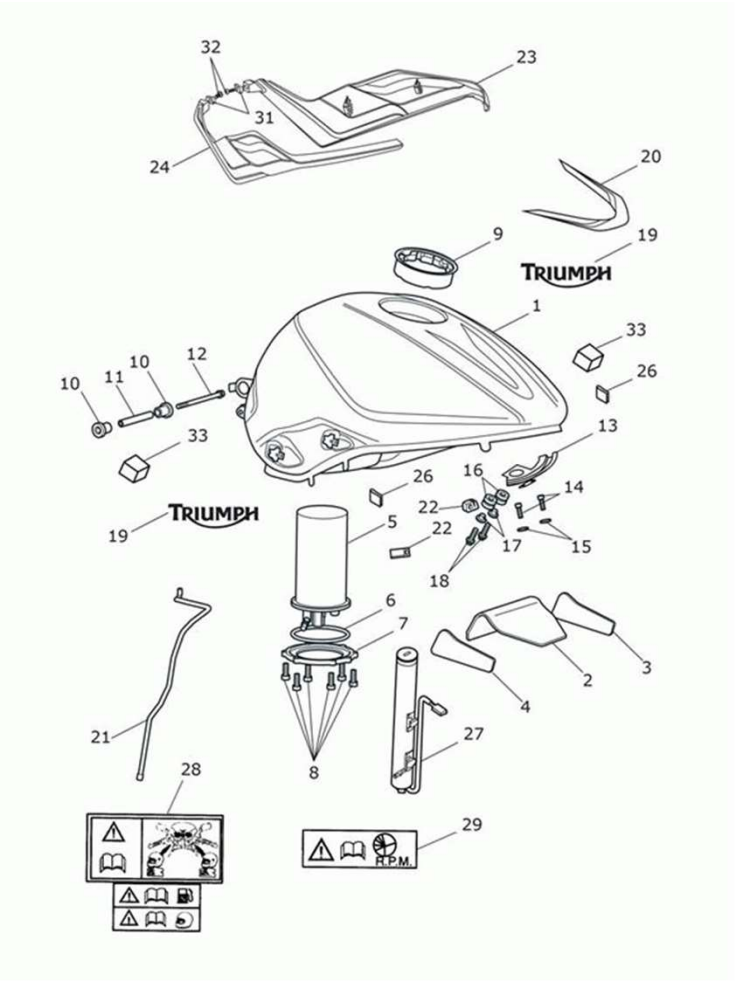


1:	HOSE, THROTTLE BODY, CYL1 T1292075	1
2:	HOSE, THROTTLE BODY, CYL2 T1292076	1
3:	HOSE, THROTTLE BODY, CYL3 T1292077	1
4:	CONNECTOR, 4-WAY T1242929	1
5:	SCREW,BUT/HD,SKT,M5X0.8X8,SLV T3332568 ★☆☆☆☆ 1.0	1
6:	VALVE,PURGE T1248990	1
7:	CARBON CANISTER, 137MM LENGTH T2409017	1
8:	CLIP, 10.5 GER OETIKER T3700077 ***USCAL, CA, HK, BR & TH Only***	1

9:	HOSE, PURGE, THROTTLE BODIES T1240407	1
10:	HOSE, EVAP, DRAIN T1240514	1
11:	HOSE, EVAP, PURGE T1240538	1
12:	HOSE, EVAP, TANK T2401586	1
13:	WIRE GUIDE, EVAP SYSTEM T2402424	2
14:	SCREW,BUT/HD,M6X1.0X12,SLV T3330726	1
15:	HOSE, EVAP, AIR T2401602	1
16:	RESTRICTOR, PURGE, EVAP T1241890 ***UK, GR, IN, DE, ES, FR, IT, NL, PT & SE Only***	3

Current Production Canister Evaluation

2020 Triumph Street Triple

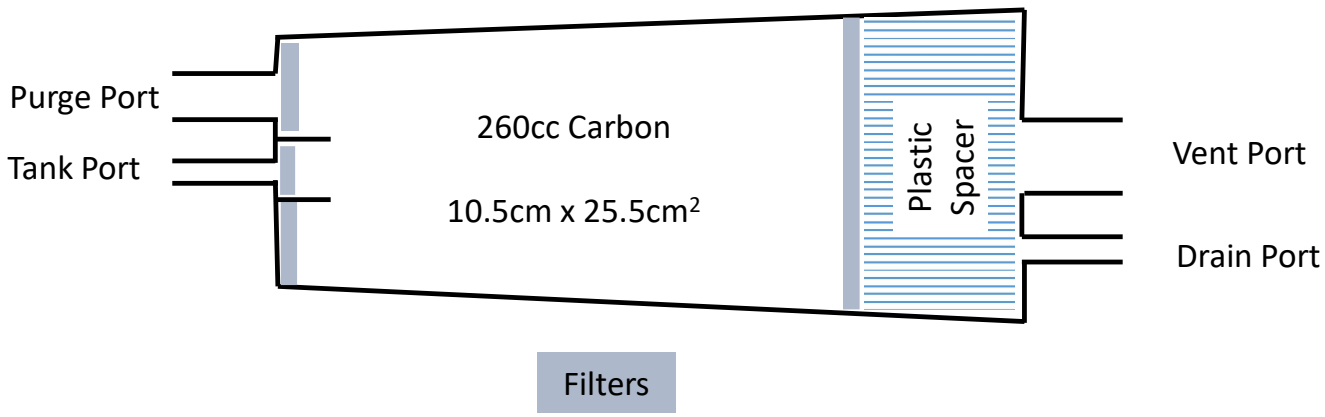


	Description Manufacturer Part #	# Required Per Assembly
2:	HEAT PAD, FUEL TANK, CENTRE T2401641	1
3:	HEAT PAD, FUEL TANK, LH T2401642	1
4:	HEAT PAD, FUEL TANK, RH T2401643	1
5:	PUMP, FUEL, 3.5 BAR T2400735	1
6:	SEAL, FUEL PUMP MODULE, E25 T2401887	1
7:	LOCATION PLATE, FUEL PUMP T2400562	1
8:	SCREW,TORX,P/H,M6*1*20,SLV T3331234	6
9:	SEAL, FUEL FILLER CAP T2405034	1
10:	BUSH,RUBBER T2400446	2
11:	TURNED SPACER, TANK MOUNT T2401070	1
12:	BOLT,HHF,LGHTD,M6X1.0X10S,SLV T3205079	1
13:	BRKT, FUEL TANK FRONT MOUNT T2405920	1
14:	SCREW,CAP/HD,M6X1.0X25,SLV T3050334	2
15:	WASHER 6.4X14X1.6 T3555004	2
16:	GROMMET, CASTELLATED T3020601	2
17:	SLEEVE,FLGD,6.4X9.6X13.4 T3010710	2
18:	BOLT,RHHF,M6X1.0X25,SLV T3200190	2
20:	DECAL, FUEL TANK, COLOUR 2 T2402272	1
21:	DRAIN HOSE, FUEL TANK T2401844	1
22:	PAD,RUBBER,FUEL TANK - FRAME T2400641	2
23:	INFILL,FUEL TANK,LH,MOULDING T2405916	1
24:	INFILL,FUEL TANK,RH,MOULDING T2405917	1
26:	S TYPE PANEL FASTENER T2405929	2
27:	FUEL LEVEL SENDER, TUBE TYPE T2405926	1
28:	LABEL,FUEL TANK,BLACK T3908400	1
29:	LABEL, RUNNING IN, DIAG T3900390 Symbols printed black	1
31:	NUT, CAPTIVE, M5 T3350129	2
32:	SCREW,BUT/HD,M5X0.8X14,SLV T3330943	2
33:	RUBBER PAD, 25X25X20MM T3660149	2

Current Production Canister Evaluation

2020 Triumph Street Triple

Canister Schematic



Current Production Canister Evaluation

2020 Triumph Street Triple

Canister Port Sizes

Purge Port

Tank Port

Vent Port

Drain Port

Current Production Canister Evaluation

2020 Triumph Street Triple

Canister Geometry

Current Production Canister Evaluation

2020 Triumph Street Triple

Canister Components

Current Production Canister Evaluation

2020 Triumph Street Triple

Activated Carbon Weight and Shape

Current Production Canister Evaluation

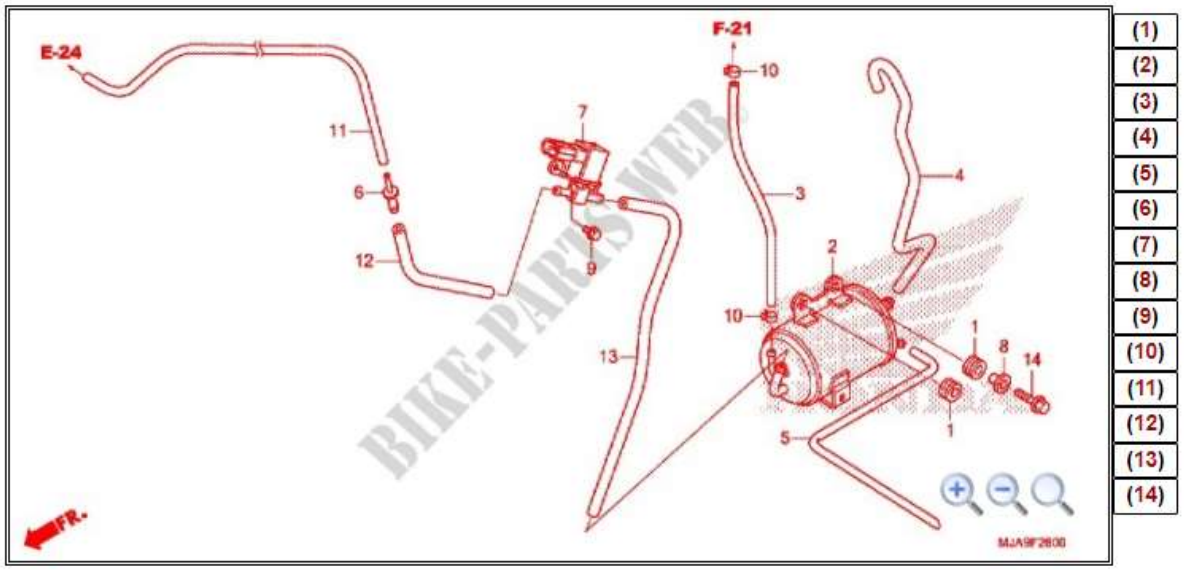
2015 Honda VT 750

Fuel Tank Volume: 14L

Canister Carbon Volume: 0.57L
Diameter 90mm
Height 120mm (180 with ports)
0.8mm wall thickness

Current Production Canister Evaluation

2015 Honda VT 750

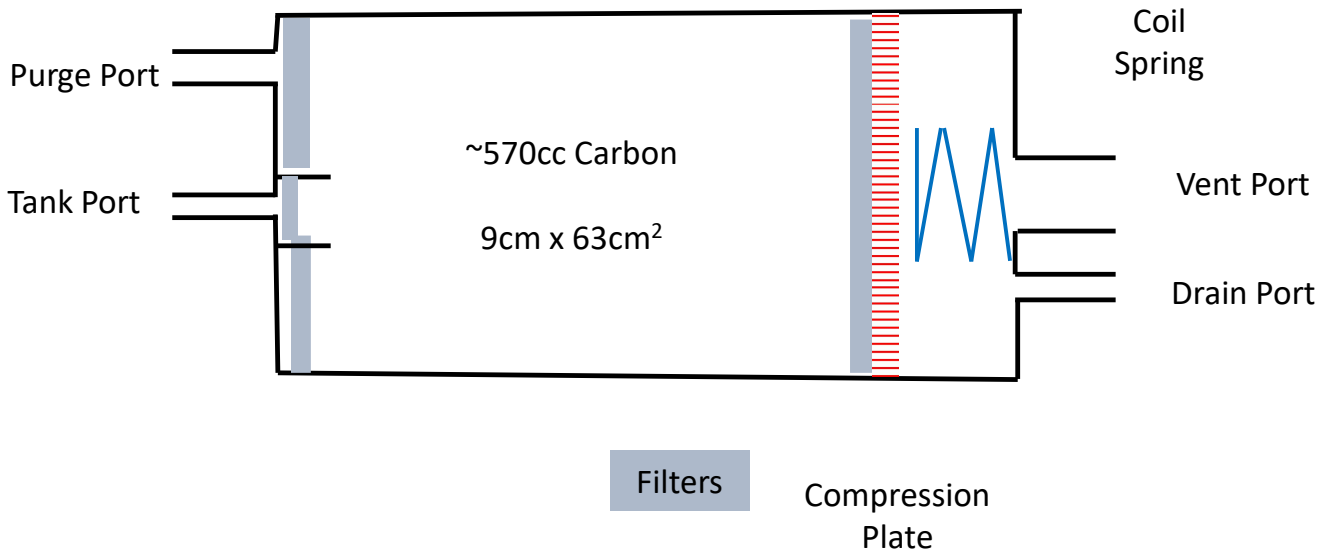


# 1	17245107010	RUBBER, AIR CLEANER CASE
# 2	17410-MEG-770 17410MEG770	CUP COMP., OIL
# 3	17411-MFE-840 17411MFE840	TUBE, CANISTER
# 4	17464-MEG-770 17464MEG770	TUBE, AIR PIPE
# 5	17465-MEG-770 17465MEG770	TUBE, CANISTER DRAIN
# 6	19126-KM1-010 19126KM1010	JOINT, TUBE
# 7	36162-MCT-681 36162MCT681	--- SOUPAPE, SOLENOIDE DE COMMANDEDEPURGE
# 8	~~61104-428-900~~ 61104-428-010	COLLAR, FR. FENDER (WHITE
# 9	90002-MC7-000 90002MC7000	BOLT, FLANGE, 5X8
# 10	95002-4073008 950024073008	CLAMP, TUBE (D7.3)
# 11	95005-3550020 950053550020	--- TUBE, 3.5X500 (95005-35001-20M)
# 12	95005-7510020 950057510020	TUBE, 7.3X100 (95005-75001-20M)
# 13	~~95005-7630020~~	TUBE, 7.3X300
# 14	95701-0602500 957010602500	BOLT, FLANGE, 6X25

Current Production Canister Evaluation

2015 Honda VT 750

Canister Schematic



Current Production Canister Evaluation

2015 Honda VT 750

Canister Port Sizes

Purge Port

Tank Port

Vent Port

Drain Port

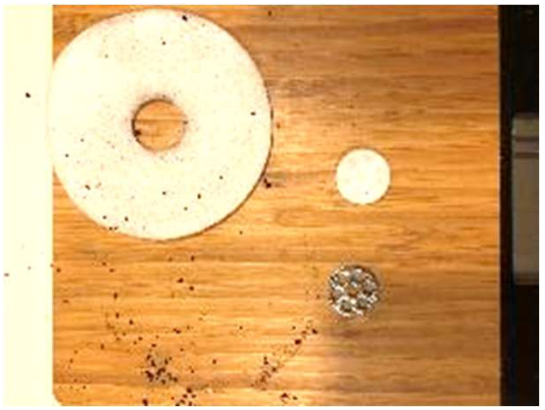
Current Production Canister Evaluation

2015 Honda VT 750

Canister Weight 560g
Carbon Weight 181g

Current Production Canister Evaluation

2015 Honda VT 750



Current Production Canister Evaluation

2015 Honda VT 750

Current Production Canister Evaluation

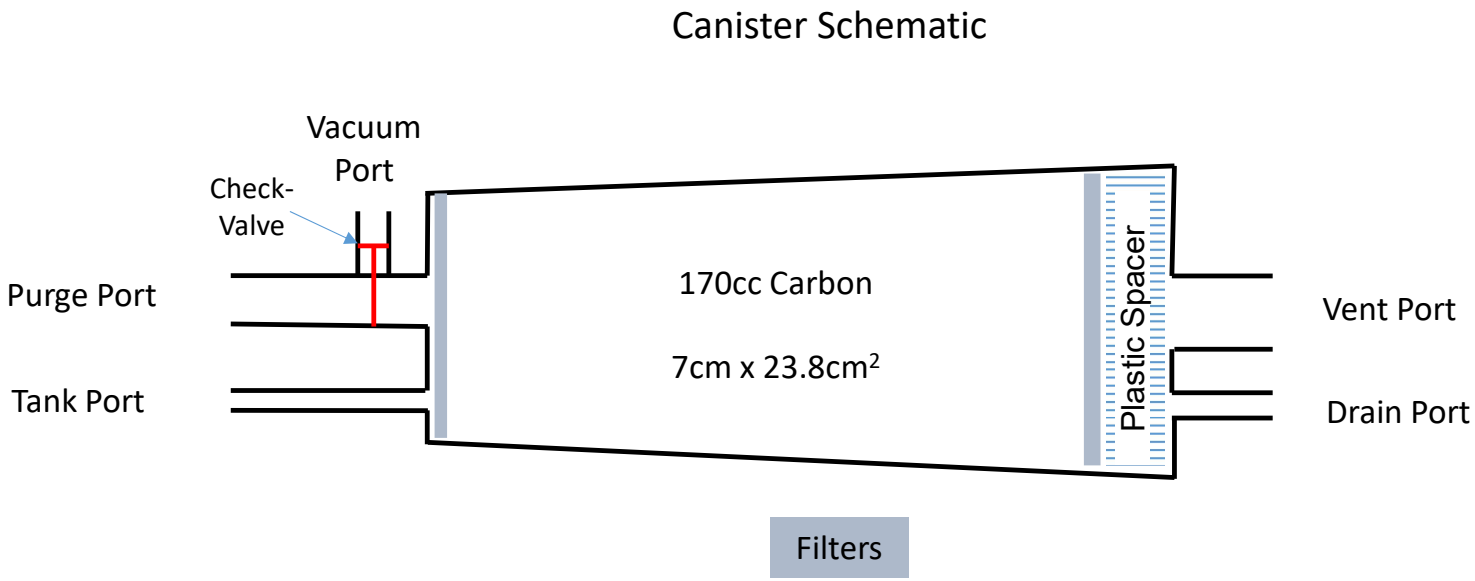
SYM Wolf 300

Fuel Tank Volume: 14L

Canister Carbon Volume: 0.17L
Diameter 65mm
Height 130mm (155 with ports)
1.5mm wall thickness

Current Production Canister Evaluation

SYM Wolf 300



Current Production Canister Evaluation

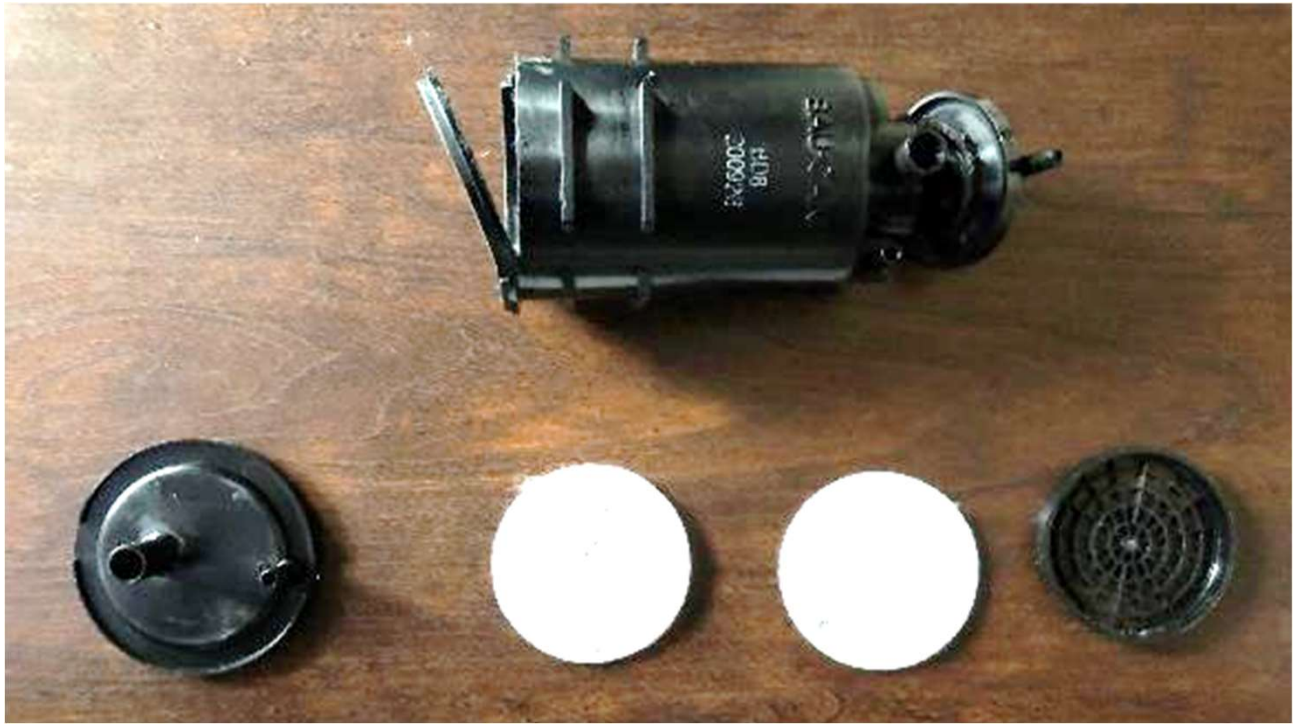
SYM Wolf 300

Canister Weight 120g
Carbon Weight 48g

Current Production Canister Evaluation

SYM Wolf 300

Canister Components



Current Production Canister Evaluation

SYM Wolf 300

Canister Port Sizes

Purge Port

Tank Port

Vacuum Port

Vent Port

Drain Port

Current Production Canister Evaluation

SYM Wolf 300

- Internal Check-Valve that opens Purge Port (towards engine) if vacuum is applied to Vacuum Port

Current Production Canister Evaluation

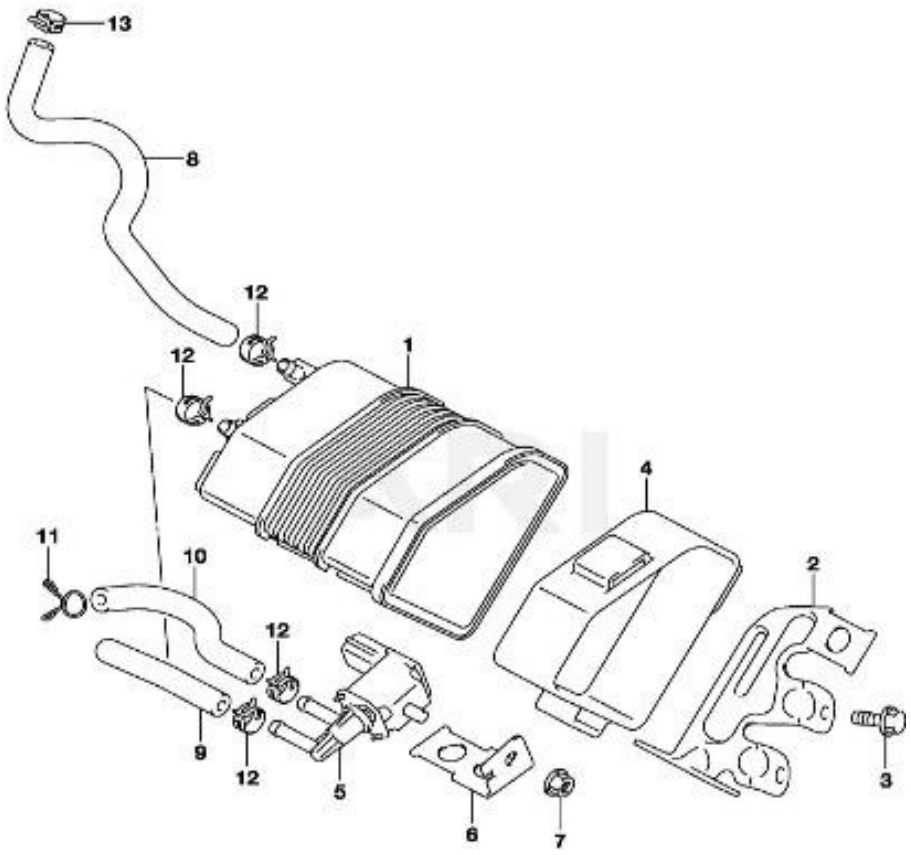
2018 Suzuki GSX-R 1000

Fuel Tank Volume: 16L

Canister Carbon Volume: 0.39L
Dimension 71x86mm
Height 121mm (136 with ports)
1.5mm wall thickness

Current Production Canister Evaluation

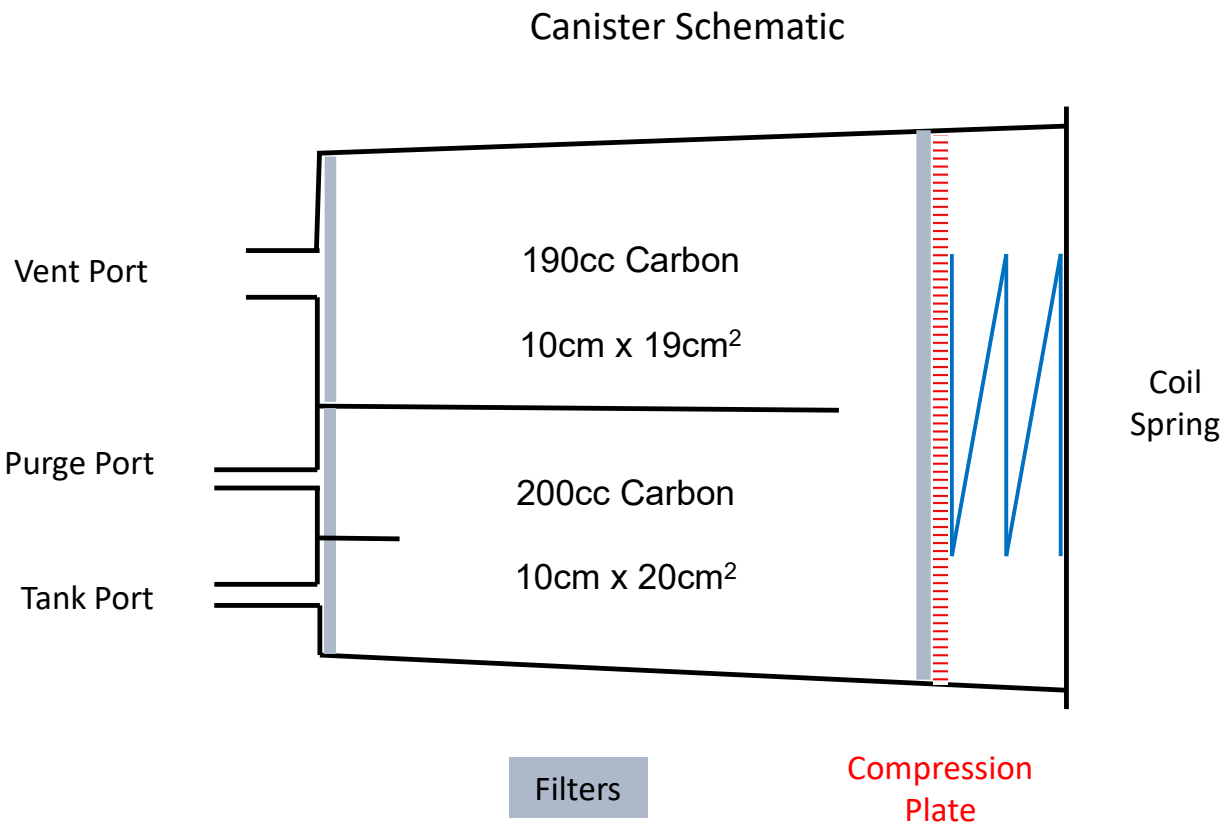
2018 Suzuki GSX-R 1000



		Manufacturer Part #	Per Assembly	Qty	Availability	Price	Price
1:	CANISTER ASSY, CHARCOAL 04K00	18560-	1	0	Ships within 1 to 2 business weeks	$82.69	$71.95
2:	BRACKET,CANISTER 17K00	18571-	1		On Backorder. None available. Notify me when this item becomes available.	$8.09	$8.09
3:	BOLT 0616A (MODEL:X	01550-	2	0	Ships within 1 to 2 business weeks	$1.62	$1.62
4:	CUSHION,CANISTER 17K00	18572-	1		On Backorder. None available. Notify me when this item becomes available.	$10.28	$10.20
5:	VALVE 5ZG10 (233)	18117-	1		On Backorder. None available. Notify me when this item becomes available.	$107.85	$91.95
6:	BRACKET,PURGE VALVE 17K00	18573-	1		On Backorder. None available. Notify me when this item becomes available.	$3.23	$3.23
7:	NUT 1006B	08316-	1	0	Ships within 1 to 2 business weeks	$2.07	$2.07
8:	HOSE,SURGE 17K00	18561-	1		On Backorder. None available. Notify me when this item becomes available.	$14.09	$14.09
9:	HOSE,PURGE NO.1 17K00	18562-	1		On Backorder. None available. Notify me when this item becomes available.	$10.28	$10.28
10:	HOSE,PURGE NO.2 17K00	18563-	1		On Backorder. None available. Notify me when this item becomes available.	$11.32	$11.32
11:	CLIP 10201-XC0	09401-	1		On Backorder. None available. Notify me when this item becomes available.	$1.67	$1.67
12:	CLIP (ID:10.5) 10409 (MODEL:C/HCA/CUP)	09401	4	0	Ships within 1 to 2 business weeks	$1.85	$1.85
13:	CLIP (ID:11) 11413	09401-	1	0	Ships within 1 to 2 business weeks	$1.85	$1.85

Current Production Canister Evaluation

2018 Suzuki GSX-R 1000



Current Production Canister Evaluation

2018 Suzuki GSX-R 1000

Canister Port Sizes

Purge Port

Tank Port

Vent Port

Current Production Canister Evaluation

2018 Suzuki GSX-R 1000

Canister Weight 257g
Carbon Weight 117g

Current Production Canister Evaluation

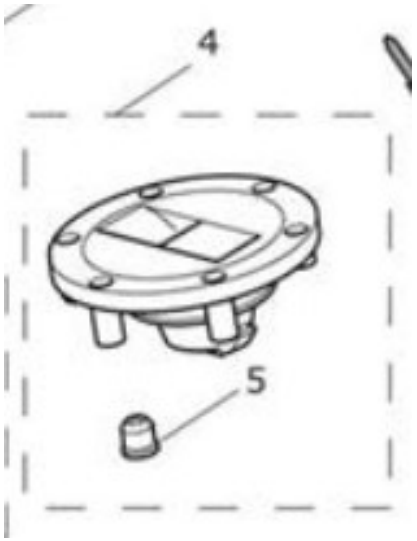
2018 Suzuki GSX-R 1000

Current Production Canister Evaluation

2018 Suzuki GSX-R 1000

Additional Slides

Triumph Gas Caps



Fuel Filler Cap, Non Vented

Stock Code T2500612

Price: $172.01

Notes: 388879 >

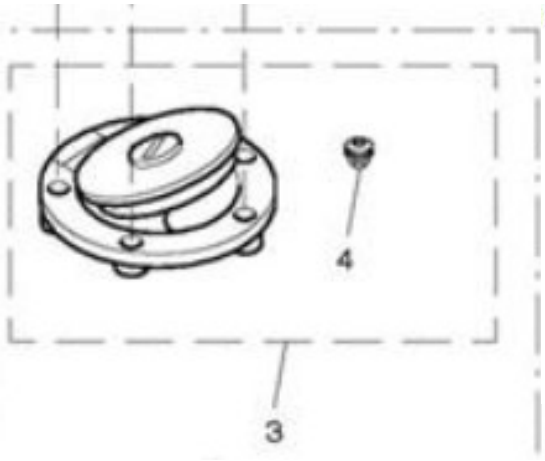
388958> (PG), 389423> (HG) & 388885> (NF) (...)

Category: Electrical System; Electrical System > Headlight Assembly; Electrical System > Ignition Switch / Lock Set

Assemblies: Ignition Switch & Lock Set

Additional Images:

4	**Fuel Filler Cap, Non Vented** 388879 > 388958> (PG), 389423> (HG) & 388885> (NF)	$172.01	T2500612
5	**Seal, Filler Cap, Breather** 388879 > 388958> (PG), 389423> (HG) & 388885> (NF)	$4.99	T2500622



Fuel Filler Cap, Non Vented

Stock Code T2500458

Price: $137.45

Notes: > 388878

>388957 (PG), >389422 (HG) & >388884 (NF)

ALL EXPT US & CA

Includes 2 keys (...)

Category: Electrical System; Electrical System > Headlight Assembly; Electrical System > Ignition Switch / Lock Set

Assemblies: Ignition Switch & Lock Set; Ignition Switch/Seat Lock; Ign Switch/Lock Set - ROW: > 356389; & 361724 > 370065 - US, CA, TW: > 356464; & 361724 > 370784; Ign Switch/Lock Set - ROW: 356390 > 361723; & 370066 > - US, CA, TW: 356465 > 361723; & 370785 >

Fuel Filler Cap, Non Vented Includes 2 keys	$137.45	T2500458
Breather Sleeve	$4.62	T2501015

Triumph Gas Caps

Triumph Gas Caps