

Pitfalls & Quality Assurance during the supply chain of biofuels in the transportation sector.

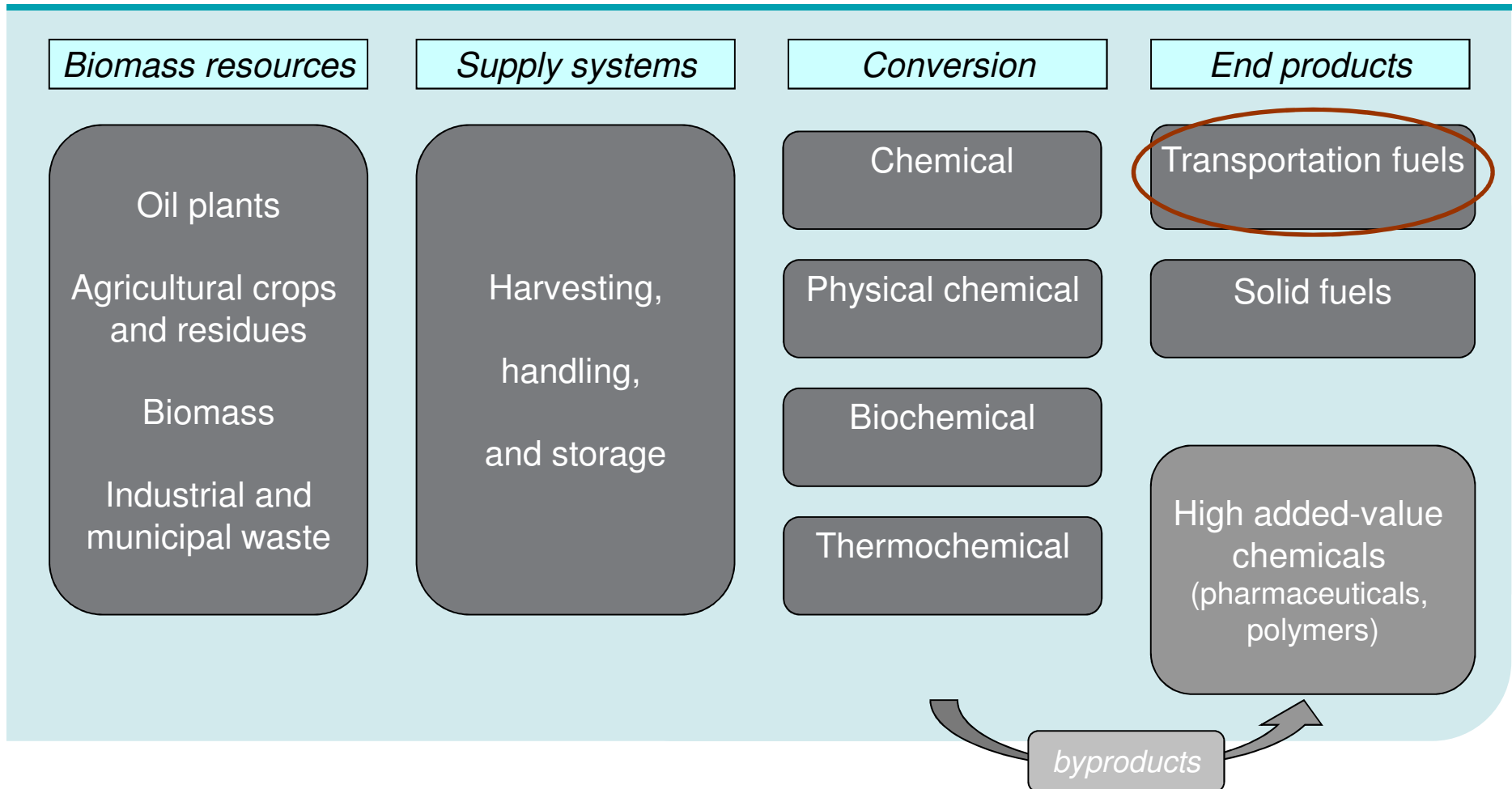
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The World Biofuels Market today : complexity!

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New Developments:

- EU push for promotion of 10% share for renewable energy in the transport sector by 2020 (Renewable Energy Directive)
- Local Governmental incentives and blending obligations (penalties)
- RED 2012: Limitation cap on contribution of food based biofuels (max 5,5%)
- Encourage a higher concentrations of advanced bio components in Road Fuels
- New type of advanced bio components (HVO, FT, pyrolysis oil, cellulosic ethanol) next to existing first generation bio fuels are entering the market
- Market Sustainability (fuel versus food) and environmental regulations of biofuels (greenhouse gas savings : 35% as from 2010 ; 50%, 2017 ; 60%, 2018)
- Fuel quality specification get stricter and more narrow due to new engine and catalyst developments (engine performance, efficiency, fuel consumption, CO2 and exhaust gas reductions)
- Introduction of bio kerosene into conventional Jet A1fuel (several test flights)

Pitfalls of the use of first generation Biofuels in automotive fuels

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The varied characteristics of an increasing range of feedstocks for FAME production and trading demand rigorous testing and inspection throughout the supply chain.

Why?

- ☐ Blends of different FAME origins (PME, SME, CME, TME, UCME,...) into supply chain
- ☐ Cold flow properties (cold start problems)
- ☐ Incompatibility with additives
- ☐ Hygroscopic Character of Bio diesel
- ☐ Filter Blocking issues
- ☐ Stability issues / Material compatibility (swelling, corrosion)

These Pitfalls are leading to technical restrictions for the existing car fleet !

Today B7 maximum & E10 maximum for the existing car fleet

Pitfall example 1: Water contaminations in Bio Fuels

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- Most critical parameter to monitor during shipping & storage
- First test which needs to be done in the laboratory at arrival of the sample
- FAME is hygroscopic and can pick up water in storage, handling or sampling !! Nitrogen blanket requirements!
- Water reacts with the esters to produce free fatty acids (reversed reaction)

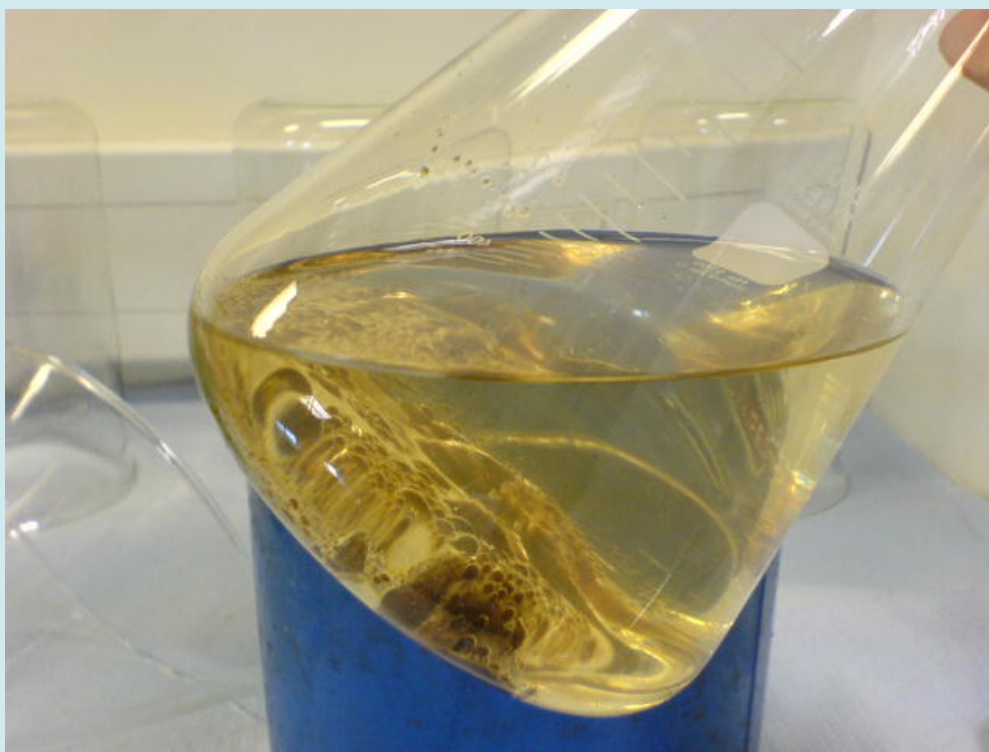


- Water supports microbiological growth (see next slide)
- Microbiological growth leads to sediments which block filters

Pitfall example 2: Microbiological infections in fuel

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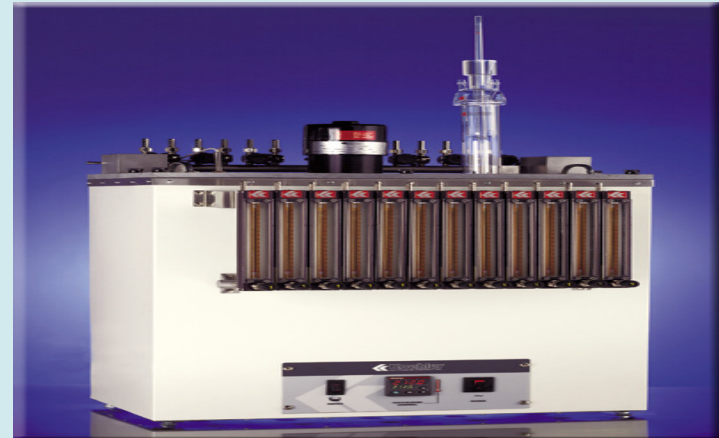


Test Case 1: Aging stability study with B10 blend (I)

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- Current standards and specifications are defined for fuel quality at point of sale, while B100 specification only apply before blending with diesel
- Standard EN 590 includes oxidation stability requirements (Rancimat EN 15751 and EN 12205)



Test Case 1: Aging stability study with B10 blend (II)

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Intertek Martique (Fr) on a sunny day

Test Case 1: Aging stability study with B10 blend (III)

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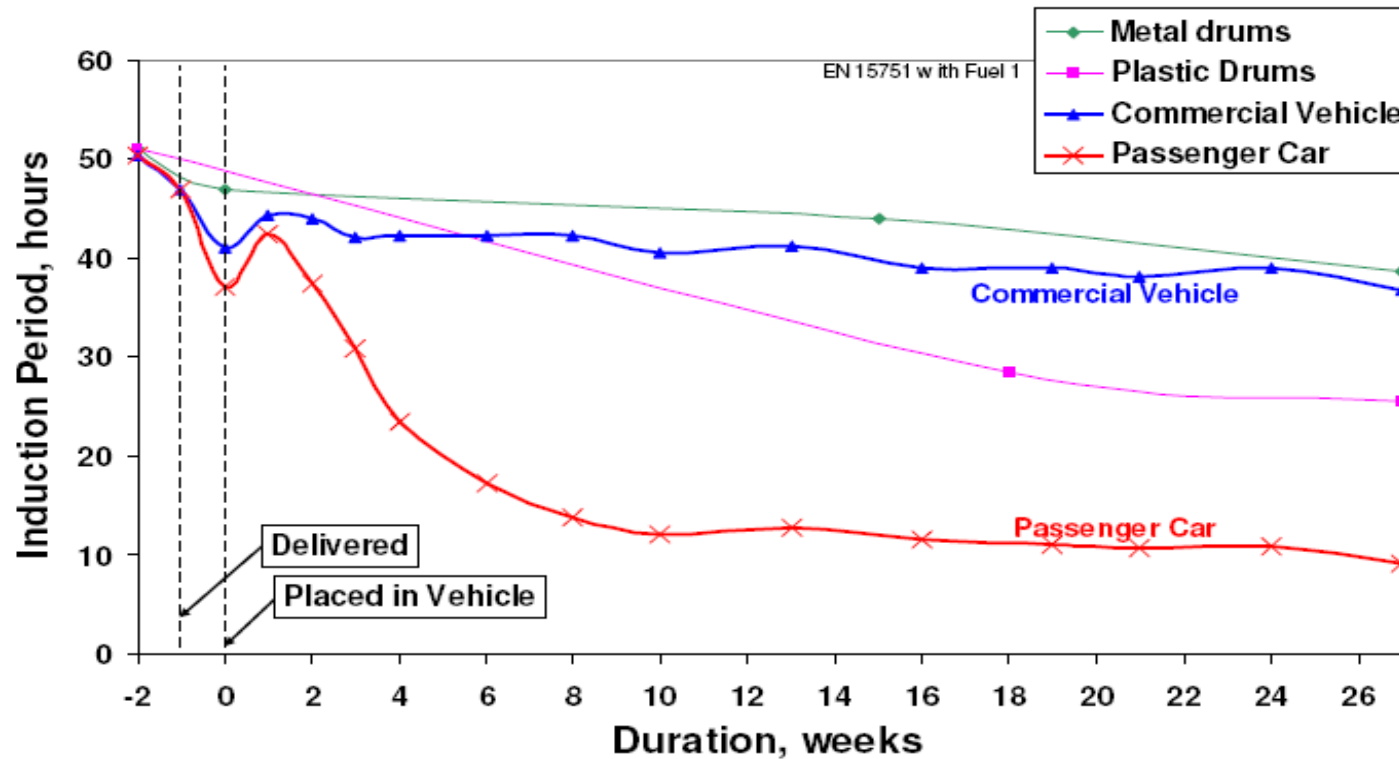


Figure 2: Aging of High Stability B10 Blend Measured Using the Rancimat
(Similar trends seen with Petroxy Test)

Source : Concawe/Acea

Test Case 2: Filter Blocking issues in biodiesel

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EN 14214:2012 has included new specifications on saturated mono-glycerides and cold flow properties to prevent from blocking filtering issues but still no Filter Blocking test (IP 387 or similar) included.

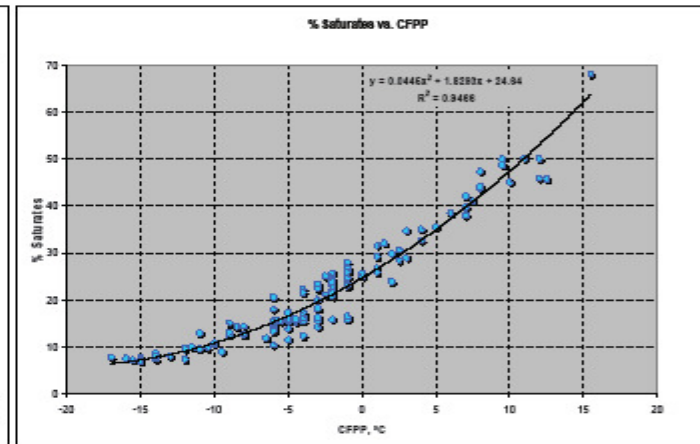
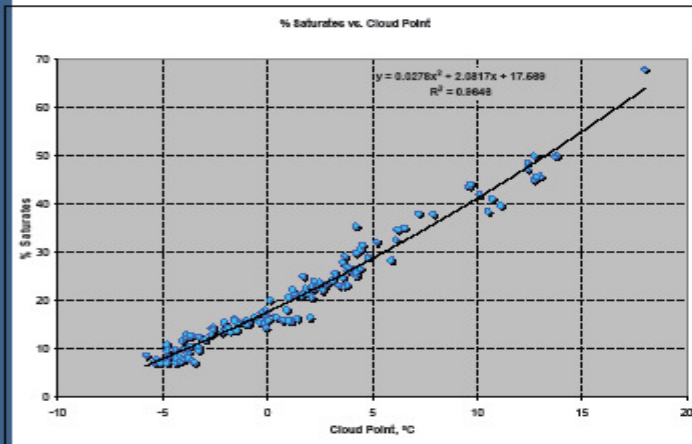


Test Case 2: Filter Blocking Issues in biodiesel

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New approach – Estimated SMG



- Large data set of FAME GC speciations analysed
- Cloud point and CFPP both correlate with % saturates from GC speciation:
 - Similar correlation coefficients
- Cloud Point correlation avoid additive influence

SMG calculation in B100:

EN14105: Monoglyceride Tontent (TMG)

Cloud Point → % Saturates ($y=0.0278X^2 + 2.0817X + 17.569$)

J.B. Engelen – 8/12/2010

$$\text{SMG} = \text{TMG} \times \% \text{ Saturates}$$

Source: Concawe



Test Case 3 : FAME cross contamination into aviation industry

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- Contamination of FAME through multiproduct pipelines or previous shipping cargoes (Diesel)
- Potential impacts for Jet Fuel when contaminated with FAME
 - * failure in Freezing Points (-47°C max) -> Pumping Concerns at low temps
 - * Reduction change in Energy -> Take off problems!!
 - * Contaminations of water, metals -> blocking of fuels & lines , corrosion
- Required LOQ DEFSTAN today: < 5 ppm FAME in Jet Fuel
- Approved test method based on GC-MS (published by Energy Institute with analytical support of Intertek Sunbury)
- New developments ongoing by Energy Institute to change the LOQ to 100 ppm max FAME in Jet Fuel, tested with HPLC test method.

Hydrotreated Refined (HVO) Diesel

- Very comparable to mineral diesel characteristics with even superior performance (+) :
 - Sulphur content : < 1ppm
 - Aromatics : < 0.1% m/m
 - Cetane Number : > **70**
 - Oxidation stability : ++
- Drop in Fuel into diesel : > 7% + without quality issues
- Applicable in existing and future cars & in existing infrastructure -> immediate effect!
- Better sustainability (no food conflict) (+)
- higher production cost (-)
- product availability today is limited (-)

Cellulose based ethanol

- Very comparable to conventional ethanol characteristics (+)
- Drop in Fuel into gasoline (+)
- Blending limitation due to vapor restrictions (waiver in EN 228:2013), alternative route is converting to Bio-ETBE or addition to BOB grades
- Better sustainability (no food conflict) (+)
- Higher production cost (-)
- Product availability today is limited (-)

Introduction of Advanced bio components (III)



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Bio Kerosene (SPK/HVO)

Typical composition analysis example (*)

Carbon Number	Normal Paraffins %	Iso Paraffins%	Cyclo Paraffins%	Aromatics%
9	3.0	8.9	0.3	< 0.1
10	3.0	22.4	0.7	< 0.1
11	2.6	21.0	0.5	< 0.1
12	1.8	16.2	0.3	< 0.1
13	1.0	9.8	0.3	< 0.1
14	0.6	3.4	0.1	< 0.1
15	1.0	3.2	0.1	< 0.1
Total	12.8	84.8	2.4	< 0.1

* Data from a Joint study of Intertek Sunbury, Rolls Royce and Air New Zealand

Introduction of Advanced bio components (III)

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Bio Kerosene (SPK/HVO)

- High amount of paraffin content (>99.5%) results in lower density (748.9 kg/m³) not meeting DEFSTAN/AFQRJOS
- No aromatics (<0.1%)
- Smoke point (+50) , better than normal jet
- Very good JF TOT results (tested up to T° 320 and no peacock or deposits)
- Low freezing point (-57°C)
- When mixed with 50% conventional fuel, products meets fully DEFSTAN/AFQRJOS test specifications (including density)

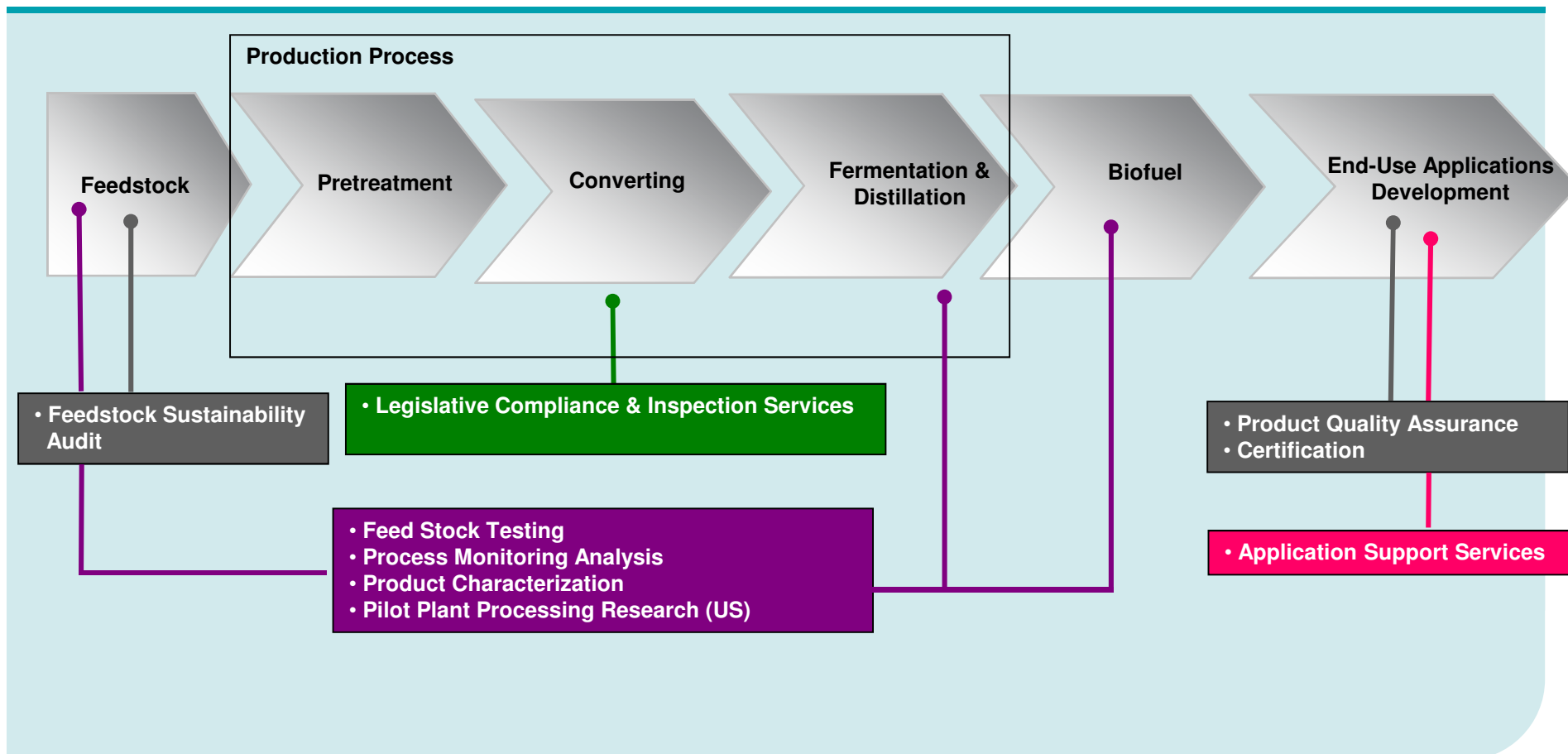
Quality of bio jet fuel (50/50) seems potentially better than conventional jet fuel



Supply chain value of Advanced BioFuels

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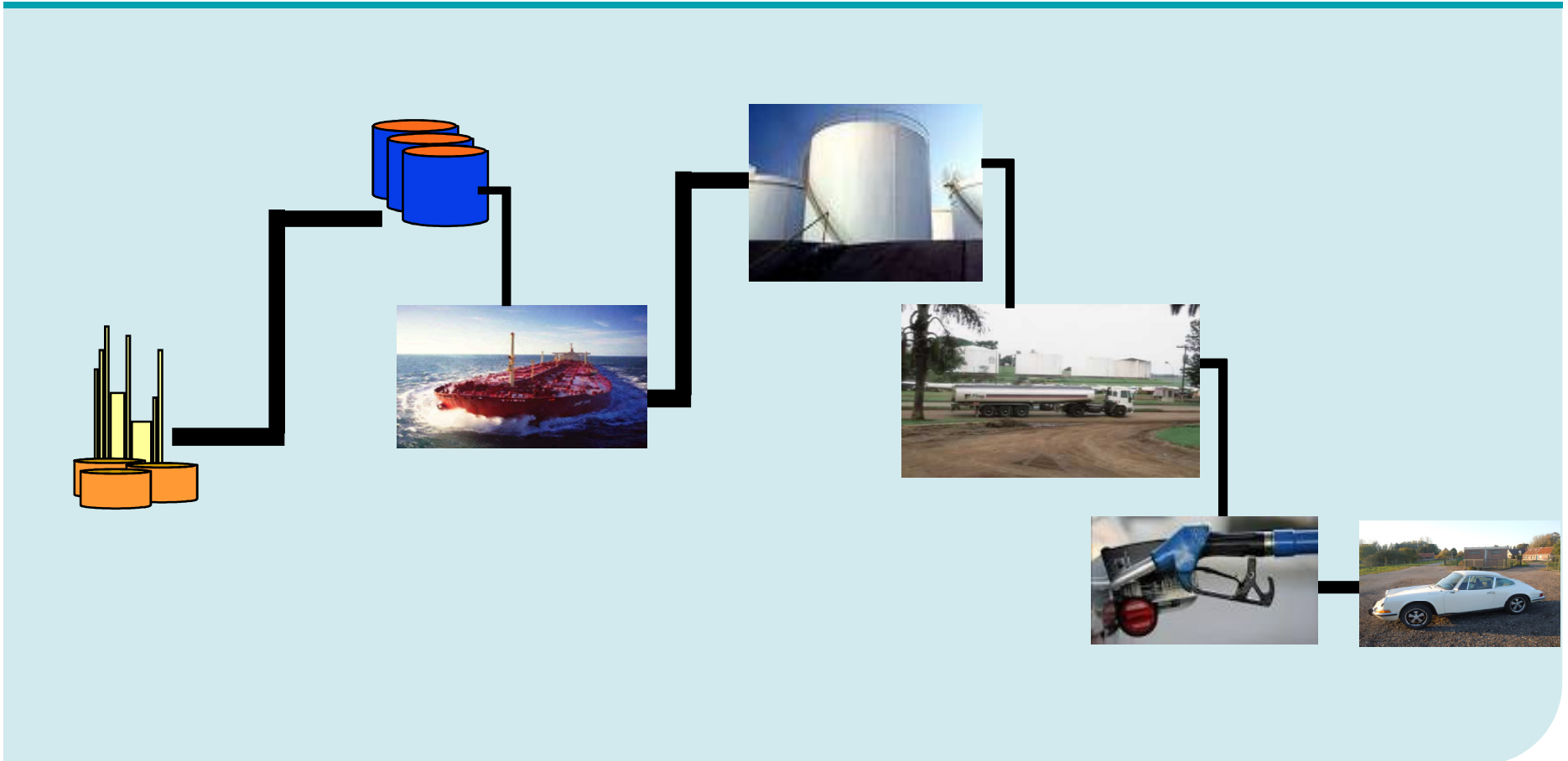


Distribution of (Bio) fuels : risks for contamination issues

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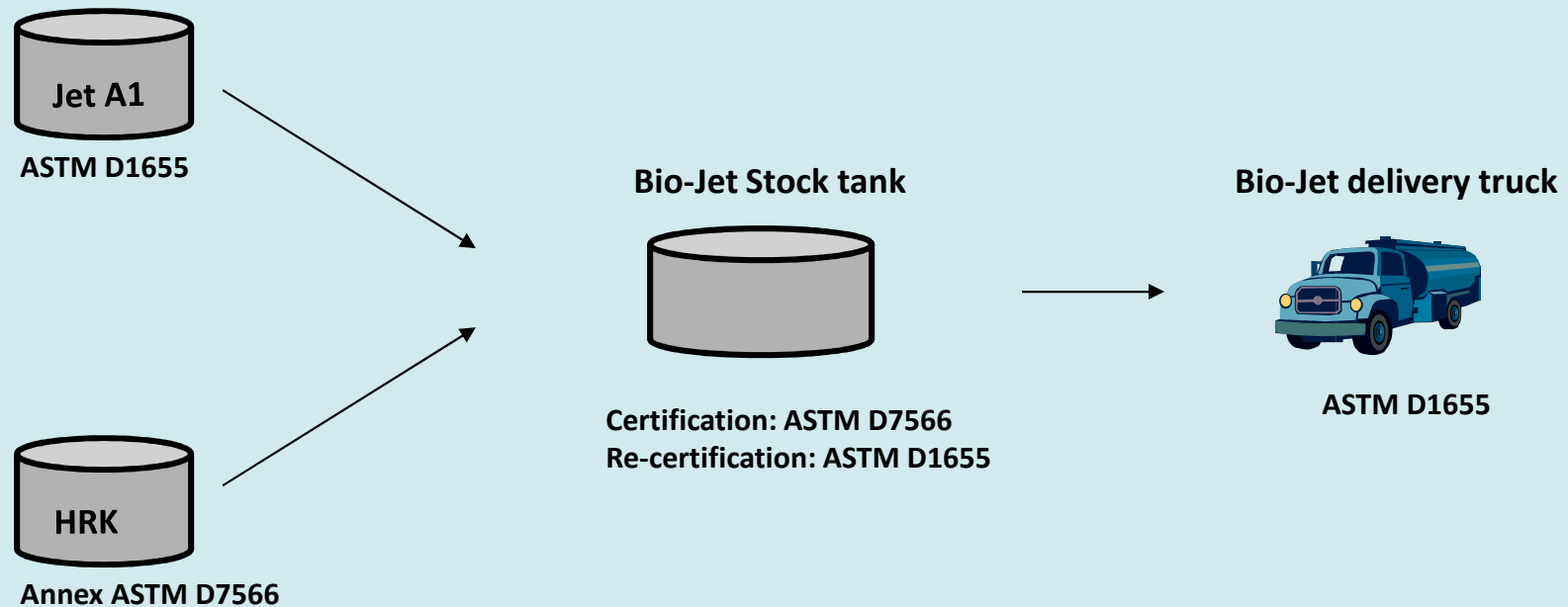
The quality of Fuel during the whole supply chain is vital to the good performance of the engine



Test Case : Bio Aviation Fuel Blending & Distribution

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Logistics of bio fuels versus testing

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- Most Bio plants constructions are smaller scale production sites compared to refineries and therefore inherently this will lead to more complex distribution chains and product will become more susceptible to contamination.
- Fuel is transported from (bio) refineries through a complex system of pipelines/ships/trucks/containers and storage terminals
- Any alternative fuel would have to be compatible with conventional fuel or it would require separate storage/distribution & delivery system.
- More complex distribution request more testing programs to secure the quality

Some other concerns

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- Risk of non-harmonized introduction & blending across 27 national different strategies.
- Need for a common EU Fuel Roadmap
- Lead time required for the development of future cars (min 5years)
- Need for future fuel specifications developed by CEN (in many cases test methods are lacking behind industrial developments)
- Risk of customer confusion at the pump with multiple fuel grades
- Non-harmonized pump labelling in EU (to prevent misfuelling need access to protection grade & clear labelling)

CONCLUSIONS

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- The quality of the fuel is vital to the success of growth of use of biofuels into transport industry.
- Automotive & aviation industry supports the use of advanced sustainable biofuels (synthetic fuels & non food based)
- Need for an EU fuel roadmap
- Most successful and cheapest way to distribute biofuels is the use of the existing network (drop in fuels) but with clear and harmonised EU labelling at the pump
- Quality & inspection surveying by qualified laboratories from processing, over transport, storage & blending activities are a **KEY** into securing the quality of the automotive fuels and to protect the consumer.

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