STANDARDIZATION OF
PURE VEGETABLE OIL (PVO)
AS DIESEL FUEL
I.F.H.V.P.
Institut Français des Huiles Végétales Pures
Membre de
EUROPEAN PURE PLANT OIL ASSOCIATION
Maison départementale de l’Agriculture
271, rue de Péchaboul - 47 000 AGEN

www.ifhvp.org
Norbert CASTAN
Vice-Président iFHVP
Président EPPOA
European Pure Plant Oil Association
Aim of the workshop

- To check for possibilities for standardization on a European level of pure oils
- To debate about hurdles encountered, problems solved and standard-type of documents needed to promote the application of pure oil fuel
2 different ways to obtain Pure Vegetable Oils

1) oil extracted by industrial process

Very fast presentation
PRESSE ET EXTRACTION DES HUILES DE GRANDES
EXEMPLE DU COLZA.

Graines 100 kg

BROYAGE

APLATISSAGE

Flocons

CUISSON

PRESSION

Huile brute de pression 34 kg

PRESSION

Huile brute 41 kg

RAFFINAGE

HUILE RAFFINEE 39-40 kg

Alimentation humaine

EXTRACTION SOLTAVANT

TOURTEAU DESHUILE 1-2% MG

TOURTEAU DE pression 66 kg

EXTRACTION DESOLVANT

HUILE brute d'extraction 7 kg

DESOLVANTATION

Alimentation animale 57 kg
LES ETAPES DU RAFFINAGE CHIMIQUE DES HUILLES VÉGÉTALES BRUTES
2 different ways to obtain Pure Vegetable Oils

2) Decentralized

hand-made
cold-first-pressing

Way of production: local energetic synergy

that’s what IFHVP promotes
Simple process - PPO as by-product
Decentralized hand-made cold-first-pressed Pure Vegetable Oil characteristics

- **Non-toxic**: no risk of inhaling toxic or carcinogenic gases, no risk of water pollution, no risk on skin contact
- **Emissions** = ideal of less pollution in converted vehicles
- **No sulphur emissions**: no risk of acid rain, soot discharges considerably reduced
- **Biodegradable, non-flammable**, no “vanishing into thin air”
- **Best energetic balance** ratio PVO to diesel = 6 : 1 (ADEME 2002)
- **Best GHG balance** ratio PVO to diesel = 1 : 7 (ADEME 2002)
In order to don’t mistake different Pure Vegetable Oils,

- IFHVP decided to call « Veget-Ole ® » the oil obtained by decentralized hand-made cold-first-pressing way of production.

- So « Veget-Ole ® » is a substitute of « gazole » (french term of diesel fossil fuel).
IFHVP promotion for *Veget-Ole*®

- Nature friendly *agriculture methods*
- Cold-first-pressing only with *mechanical tools* and without solvents
- *Careful filtration* to obtain fuel quality
- Use of oil fuel in *converted vehicles*
Advantages expected by implementing IFHVP *Veget-Ole*® protocol

- Advantages for Environment and Nature (bees...)
- A few hundred km of transport avoided
- Oil locally suitable as fuel replacing fossil fuel
- Fat rich protein cake locally suitable for livestock feed replacing soybean cake
- Benefits for rural areas economy and social situation of farmers, country planning

*Details STEP by STEP...*
<table>
<thead>
<tr>
<th>Step</th>
<th>What IFHVP promotes</th>
<th>Why</th>
<th>Advantages</th>
<th>Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>soil preparation</td>
<td>no ploughing, low pressure inflated tyres</td>
<td>let do micro life of superficial soil, don’t compact soil</td>
<td>soil better for growing, less fuel consumption, work and expense</td>
<td></td>
</tr>
<tr>
<td>growing</td>
<td>no chemical products</td>
<td>avoid grass by mechanical tool, let do natural predators</td>
<td>avoid chemical products, less pollution and expense</td>
<td></td>
</tr>
<tr>
<td>harvest</td>
<td>leave straw on soil</td>
<td>self-manure of soil</td>
<td>no chemical manure needed</td>
<td></td>
</tr>
<tr>
<td>oilseeds storage</td>
<td>in farm</td>
<td>for local transformation</td>
<td>avoid transport, keep harvest ownership</td>
<td>need a warehouse</td>
</tr>
<tr>
<td>pressing</td>
<td>cold-first-pressing by only mechanical tools</td>
<td>preserve natural characteristics of 2 products</td>
<td>non-toxic, easy, cheap, less long molecular chain</td>
<td>need tools, guidance documents and councils</td>
</tr>
<tr>
<td>Step</td>
<td>What IFHVP promotes</td>
<td>Why</td>
<td>Advantages</td>
<td>Drawbacks</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------------------</td>
<td>-------------------------------------------</td>
<td>-----------------------------------------------------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>oil using</td>
<td>replacing diesel fuel</td>
<td>no profit in France by replacing tractor- fuel</td>
<td>avoid transport, keep gains in rural areas, less fossil fuel imports</td>
<td></td>
</tr>
<tr>
<td>cake using</td>
<td>replacing soybean cake</td>
<td>fat rich protein cake suitable for livestock feed (or natural manure)</td>
<td>traceability, keep gains in rural areas, less soybean cake imports</td>
<td></td>
</tr>
<tr>
<td>oil storage and tank filling</td>
<td>dialysis and carefulness filtration</td>
<td>avoid molecular reformulation</td>
<td>oil suitable as fuel</td>
<td></td>
</tr>
<tr>
<td>using oil as fuel</td>
<td>in converted vehicles</td>
<td>different of diesel : viscosity, flash point</td>
<td>best lubricant fuel, less pollutants, better couple and power, engine longevity</td>
<td>conversion legality and cost, engine warranty, oil supply</td>
</tr>
</tbody>
</table>
At European level, IFHVP propose to name oil obtained by decentralized hand-made cold-first-pressing as « VOLF » for Virgin Oil Liquid Fuel.

- **Virgin** = natural oil obtained only by mechanical cold-first-pressing process (without chemical product in any stage of production)
- **Liquid** = always liquid even at cold temperatures (e.g. rapeseed and sunflower oil), by cold-first-pressing and adapted filtration
- **Fuel** = suitable as fuel (conformity to Weihenstephan pre-norm)

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Technical innovations, relevance
And results

Frederic PERRIN
Engineer in Environment - Project Manager

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Innovation and relevance

- **German PVO norm DIN 51605**: limits of the analytical standards
  
  **But**: bad repetability, need to work on range of temperature and solvant quantity (viscosity)

  **Development of a special analytical standard for all type of VOLF (sunflower, Jatropha, ...)**

  - Case of water content (Karl Fischer method): the content is so weak that the measure goes out of the device range
Innovation and relevance

- Consequences on process
  - conditions of sampling,
  - conditions of storage,
  - filtration efficiency: use of specific filtration medium
    - Cut threshold
    - Determination of retention capacity

- 2 work tracks:
  - Global comprehension of production process
  - Research on specific material for techniques of separation
Veget-Ole® for VOLF

➢ Why ?
  To guarantee the tracking and the product quality, for the producer and for the user

➢ How ?
  ✓ determination of critical points on process: cutting of the process by area
  ✓ audit on site (questionnaire), in the presence of the producer
  ✓ VOLF analyzes on 4 essential parameters (2 analyzes per year)

  ▪ Water content,
  ▪ Phosphorus content,
  ▪ Acidity value (TAN)
  ▪ Total contamination

  reference to the DIN 51605

➢ Main points on results :
  ➢ Enclosed space: not necessarily set up
  ➢ techniques of separation and filtration quality

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## Properties / Contents

| Characteristic properties for Rapeseed Oil |

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Limiting Value</th>
<th>Testing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (15 °C)</td>
<td>kg/m³</td>
<td>900</td>
<td>930</td>
</tr>
<tr>
<td>Flash Point by P-M</td>
<td>°C</td>
<td>220</td>
<td>DIN EN 22719</td>
</tr>
<tr>
<td>Calorific Value</td>
<td>kJ/kg</td>
<td>35000</td>
<td>DIN 51900-3</td>
</tr>
<tr>
<td>Kinematic Viscosity (40 °C)</td>
<td>mm²/s</td>
<td>38</td>
<td>DIN EN ISO 3104</td>
</tr>
<tr>
<td>Low Temperature Behaviour</td>
<td></td>
<td></td>
<td>Rotational Viscosimeter testing conditions will be developed</td>
</tr>
<tr>
<td>Cetane Number</td>
<td></td>
<td></td>
<td>Testing method will be revised</td>
</tr>
<tr>
<td>Carbon Residue</td>
<td>Mass-%</td>
<td>0.40</td>
<td>DIN EN ISO 10370</td>
</tr>
<tr>
<td>Iodine Number</td>
<td>g/100 g</td>
<td>100</td>
<td>120</td>
</tr>
<tr>
<td>Sulphur Content</td>
<td>mg/kg</td>
<td>20</td>
<td>ASTM D5453-93</td>
</tr>
</tbody>
</table>

## Variable properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Limiting Value</th>
<th>Testing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contamination</td>
<td>mg/kg</td>
<td>25</td>
<td>DIN EN 12662</td>
</tr>
<tr>
<td>Acid Value</td>
<td>mg KOH/g</td>
<td>2.0</td>
<td>DIN EN ISO 660</td>
</tr>
<tr>
<td>Oxidation Stability (110 °C)</td>
<td>h</td>
<td>5.0</td>
<td>ISO 8886</td>
</tr>
<tr>
<td>Phosphorus Content</td>
<td>mg/kg</td>
<td>15</td>
<td>ASTM D3231-99</td>
</tr>
<tr>
<td>Ash Content</td>
<td>Mass-%</td>
<td>0.01</td>
<td>DIN EN ISO 6245</td>
</tr>
<tr>
<td>Water Content</td>
<td>Mass-%</td>
<td>0.075</td>
<td>pr EN ISO 12937</td>
</tr>
</tbody>
</table>
Filtration threshold: results on sunflower VOLF

Clarification 3 months - Barrel Press - sampling of 100 cm³

After filtration 2µm abs - retention capacity of 125 g - 1 pass

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IFHVP Development in France with districts
Communauté de Communes du Villeneuvois (47) :

✓ Running on VOLF (sunflower) since nov. 2005
✓ 10 refuse lorries (the worst conditions for engines!)
  ✓ 4 on HP injection (DCI) running on 30% VOLF
  ✓ 5 direct injection models converted (2-tank system) running on 100% VOLF
➢ VOLF from Végétole® producers

Between November 2005 and November 2007, on 10 refuse lorries:

• 100 517 liters of consummate diesel fuel,
• 125 824 liters of consummate PVO,
• 359 443 km covered

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IFHVP Development in France

Communauté de Communes du Val de Garonne (47):

- Running on VOLF (sunflower) since jan. 2008
- 10 trucks with 30% VOLF: 6 lorries and 4 vans
- VOLF from one Végétole® producer

During 2008:

- 18 900 liters of consummate diesel fuel,
- 8 100 liters of consummate VOLF,
- 118 000 km covered

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IFHVP Development in France

Communauté of Montauban Trois Rivières (82):

- Running on VOLF (sunflower) since oct. 2008
- 31 vehicles with 5, 15 or 30% VOLF (according to engine guarantees)
- VOLF from one Végétole® producer

Cuma BioEnergies 82
International IFHVP Development

- **Madagascar**
  - Study in 2007/2008
  - project of usage of vegetable oil of Jatropha for the rail traction
  - Goal = local energetic diversification and social development alongside the rail

- **Senegal**
  - local energetic diversification with VOLF from Jatropha and food farming
  - Work on plastic recycling (HORTIS)
  - Partnerships with the ISRA (Senegalese Institut for agricultural research) and a local association (DiaspoReva)
  - Project envolved in the REVA program

IFHVP - CEN - 2009/03/19
Results of using VOLF

- Végétole® results

<table>
<thead>
<tr>
<th></th>
<th>Total contamination (ppm)</th>
<th>Water content (ppm)</th>
<th>TAN (mg KOH/g)</th>
<th>Phosphorus (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIN 51605</td>
<td>24</td>
<td>750</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>CCV (47)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAEC de Lustrac</td>
<td>13</td>
<td>464</td>
<td>1.04</td>
<td>9</td>
</tr>
<tr>
<td>GAEC La Forêt</td>
<td>6</td>
<td>435</td>
<td>0.93</td>
<td>4</td>
</tr>
<tr>
<td>CCVG (47)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EARL Gourgues</td>
<td>20</td>
<td>655</td>
<td>0.36</td>
<td>0</td>
</tr>
<tr>
<td>Montauban (82)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuma Bioenergies 82</td>
<td>22.7</td>
<td>490</td>
<td>1.37</td>
<td>4</td>
</tr>
</tbody>
</table>

Even if some results are at the threshold of the DIN 51605, it must be considered that:

- by knowing exactly the process line, suitable conditions and materials would be advocated (e.g. special filtration from 5 to 2 µm abs),

- By knowing exactly the human parameter, some results as total contamination would be explained and not all product would be classified as “Not fuel Quality”

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Results of using VOLF

- **Végétole®** tracks:
  - Sensitization of producers to quality factors
  - Use of specific filtration regarding:
    - Economic costs
    - Capacity of treatment: volume treated per cartridge
    - Threshold of residual contamination

According to the ACEA Worldwide Fuel Charter:
- Contamination: 10 ppm (EN590: 24 ppm),
- Particules counting: **ISO 4406 = 18/16/13** (none for EN590)

Test of filtration (1 pass on 2 µm abs Hydac® - rapeseed oil - clarification 6 months): Particule counting: **ISO 4406 = 16/14/10**
Technical results on vehicles

Case of CCV : expertise by CIRAD (10/17/2008)

- Endoscopy of engines running on 30% and 100% VOLF,
- Dismantling of one cylinder after 1000 hours working, 25 000 l VOLF consummate, since nov. 2005:

No premature wear

"Some deposits are visible, in particular on the admission valve, in proportions not very important. One meets this deposit type in the motors to pure diesel fuel. Only shininess could indicate us a usage in PVO. A quotation motor would have given assuredly a close grade of 10/10."

IFHVP - CEN - 2009/03/19
Technical results on vehicles

In global (for all districts running on VOLF in France):

✓ No engine broken,
✓ No power loss,
✓ Less pollution,
✓ Good behaviour of vehicle
Pollution controls

- Comparatives studies of the pollutant load between vehicles running on pure diesel fuel and vehicles running with VOLF (30% or 100%).
- Special case of analyse : no engine load, 2 speeds.
- Measure of quality load, not quantity of pollutants: do not compare with European emission standards

**Average results :**

<table>
<thead>
<tr>
<th>Average gap</th>
<th>CO</th>
<th>CO₂</th>
<th>HC</th>
<th>NOₓ</th>
<th>Opacity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>100% PVO (CCV)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>-22%</td>
<td>-1.4%</td>
<td>+2.6%</td>
<td>-3.5%</td>
<td>-29%</td>
</tr>
<tr>
<td>Max</td>
<td>-25%</td>
<td>+3%</td>
<td>+9%</td>
<td>+1.5%</td>
<td></td>
</tr>
<tr>
<td><strong>30% PVO (CCVG)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>-7%</td>
<td>0%</td>
<td>-25%</td>
<td>-56%</td>
<td>-4.2%</td>
</tr>
<tr>
<td>Max</td>
<td>+33%</td>
<td>-33%</td>
<td>+600%</td>
<td>+33%</td>
<td>-71.4%</td>
</tr>
</tbody>
</table>

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Pollution controls

Case of CCV: NO\textsubscript{x} variation between 30% and 100% VOLF

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CO\textsubscript{2} variation on HP injection

Engine models: Renault DCI 270

CO\textsubscript{2} variation (650 rpm)

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### Energy and Carbon balances

<table>
<thead>
<tr>
<th></th>
<th>Fuel</th>
<th>Rapeseed Biodiesel</th>
<th>Sunflower biodiesel</th>
<th>Rapeseed oil</th>
<th>Sunflower oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Returned energy / fossil energy mobilized</td>
<td>0.917</td>
<td>2.99</td>
<td>3.16</td>
<td>5.45</td>
<td>6.33</td>
</tr>
<tr>
<td>GHG (g eq. CO₂/kg)</td>
<td>3394</td>
<td>888</td>
<td>745</td>
<td>660</td>
<td>498</td>
</tr>
</tbody>
</table>

From Ecobilan ADEME/DIREM/PHWC 2002

The district of Montauban has estimated that by using 30% of VOLF in 30 vehicles during 1 year, **150 tons of CO₂ would be saved.**

Calculating both balances regarding to:

- Cultural routes
- Short scale process lines
- Direct use

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Hurdles encountered and what IFHVP expected from European Commission in order to really uptake VOLF
## Biofuel Properties

<table>
<thead>
<tr>
<th>Matter</th>
<th>It should be</th>
<th>Why</th>
<th>Advantages</th>
<th>Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>oil fuel standard</td>
<td>based on VOLF properties, don't try to get diesel characteristics</td>
<td>keep 100% natural product</td>
<td>promote VOLF in farm 100% natural production</td>
<td><em>NO MORE BARRIER FOR FARMER!</em></td>
</tr>
<tr>
<td>engine makers</td>
<td>“flex-fuel” diesel-VOLF</td>
<td>avoid oil supply difficulties, less conversion expense</td>
<td>less cost because of large scale production, engine warranty</td>
<td>R&amp;D cost</td>
</tr>
<tr>
<td>legality</td>
<td>free to use VOLF in car, trucks, etc. all over EC</td>
<td>still forbidden in France (because of compatibility clause?)</td>
<td>End of discrimination in comparison with PVO in Germany and with Diester®</td>
<td></td>
</tr>
<tr>
<td>taxation excise duty</td>
<td>VOLF free of excise duty all over EC</td>
<td>VOLF best biofuel</td>
<td>kill a real barrier to uptake, less aids to farmers required</td>
<td></td>
</tr>
</tbody>
</table>

*IFHVP - CEN - 2009/03/19*
<table>
<thead>
<tr>
<th>Matter</th>
<th>It should be</th>
<th>Why</th>
<th>Advantages</th>
<th>Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>taxation VAT</td>
<td>agricultural reduce rate</td>
<td>full VAT rate in France</td>
<td>avoid distortion all over EC</td>
<td></td>
</tr>
<tr>
<td>R&amp;D subsidiaries</td>
<td>subsidiaries harmonized between all biofuels</td>
<td>french excise duty covered special tax for IFP owner of Diester® patent</td>
<td>R&amp;D (standardization, GHG reduce calculation) information and advices to farmers/users</td>
<td></td>
</tr>
<tr>
<td>Councils to producers and users</td>
<td>European guidance documents and official VOLF advisors (EPPOA is a wealth of that kind!)</td>
<td>Difficult to get good an complete information needed Most of volunteers through Europe (not yet VOLF lobby!)</td>
<td>Insure oil quality for both farmers and users benefits</td>
<td>Budget for VOLF advisors expertise</td>
</tr>
<tr>
<td>VOLF uptake</td>
<td>implementation of legal and fiscal quoted measures</td>
<td>avoid discrimination and distortions, do promotion of VOLF</td>
<td>get a great and real progress in sustainable development all over EC</td>
<td></td>
</tr>
</tbody>
</table>

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To conclude: be pragmatic...

- An oil quality standard (Weihenstephan)
  Base on VOLF characteristics,
- A specific VOLF pollutants standard
  Lift some limits
- New contamination measurement standard
- Guidance documents
  For farmers and users
- Public founds for really involved advisors (*)
  (*) from non-profit organization which aims quote clearly VOLF
...and don't deceive farmers!

- Farmers: “a standardization, what’s for?”

- IFHVP: “standardization is a step for VOLF promotion, and we will tell to European Commission that all other steps (engine aptitude, legality, taxation, R&D, guidance documents and putting in place advisors) should be started at the same time.”

- Farmers: “Otherwise it doesn’t worth!”

Now farmers trust in our collective work to banish all hurdles we encounter today. Thank you to don’t deceive them!

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Institut Français des Huiles Végétales Pures

« From Will to Well »

Member of « European Pure Plant Oil Association »

Pure Plantoil for Peace!

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