# Functional Requirements of the Alphasole Prototype

French version here

Spanish version here

## Design requirements

Within the scope of collaborative research, we work on the requirements of each element developped thereafter in the following sections. The discussion history between contributors is available through the links to the forum (in French):

L'historique des discussions entre contributeurs est accessible par les liens respectifs vers le forum :

- Structure forum [http://forum.osefrance.org/viewforum.php?f=9] ,
- Concentrator optic forum [http://forum.osefrance.org/viewforum.php?f=10] ,
- Engines, Program, Captors forum [http://forum.osefrance.org/viewforum.php?f=12] ,
- Absorber forum [http://forum.osefrance.org/viewforum.php?f=11] .

## General

| Requirement | Demonstrator | Prototype | Comments for prototype |
|---|---|---|---|
| Reduce risks | Pay attention to parasitic reflexions | * optical risks ; * risks related to high pressure and high temperature hydraulic circuit | |
| Cost (material, production, manufacturing, assembling) | Minimum | Minimum: <300€/m² | Savings possible with respect to demonstrator but not yet optimized |

### 3) Concentrator optic

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| Requirement | Demonstrator | Prototype | Comments for prototype |
|---|---|---|---|
| Optical efficiency | Reflectivity (at normal angle) 0.9 | 60-70% | To fienetune: relevant/optimized geometry, cf cf discussion/forum ; reflectivity of mirrors >= 0.9 ; other parameters : fouling, cleaning frequency, evolution through lifetime |

| Requirement | Demonstrator | Prototype | Comments for prototype |
|---|---|---|---|
| Robustness and lifetime | no requirement | 3 to 5 years | To be studied : * time? * warranty? * what efficiency loss? * renewal point, maintenance frequency. * economic balance? * also to be written in other sections : structure, optic. *to define: expensive elements, frame elements last longer: 20 years or more |
| Accesibility for cleaning and maintenance | no requirement | yes | *easy cleaning of the mirrors; *maintenance and tuning of the facets once mounted; *access to receptor once mounted |
| Thermal efficiency of the receptor | secondary concentration on the receptor > 1.5 | 70-80% efficiency as a goal | |
| Total concentration factor | between 15 and 30 | between 15 and 30 | With 20 mirrors, it reaches about 15 |
| Secondary reflector (CPC) : design coordinated with absorber | 60% | yes | |

## Structure

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#### Frame of mirrors set and receptor

| Requirement | Demonstrator | Prototype | Comments for prototype |
|---|---|---|---|
| Independant structure: mirror, receptor | yes | No | Fixed relative position, to be set in accordance with latitude |
| Resistance to ambiant environment | yes, punctually | yes, permanently | wind speed, hail, rain, snow, dust |
| Sufficient stiffness against vibrations and deformation | yes | yes | |
| Ground fixing | Adjustable feet | Fixed | Concrete base to be planned or fixation to an existing structure, roof... Study carefully stiffness, stability... |
| Assembling easiness | yes | yes | kit possible |
| Transport easiness | yes | no | |
| Welding | the least possible | Ok | No requirement initially, compromise between : building complexity and assembling easiness |
| Limitation of accident risks | yes | yes | at all stages : manufacturing, assembling |

#### Structure of mirrors facets

| Requirement | Demonstrator | Prototype | Comments for prototype |
|---|---|---|---|
| Fresnel mirror: area | 2×2 m$^2$ with 20 facets 10 cm wide | defined by the power need (5KW ) | |
| Mirror deformation limitation | deflection lower than 5 mm | 0.1° facet orientation, respectively 1cm on the receptor | (a priori) depends on receptor height, valid for 1.5m height |
| Sun tracking (east west) | >120° respectively 8h tracking | 12h tracking | respective rotation of 90° in 12h |
| Bad weather protection | yes | yes | for instance: 180° range (mirrors down) |
| Optical alignment possible through a tuning needless of special tools | yes | yes | Better: procedure to be updated for calibration |
| Easy switching of mirror facets | yes | yes | more generally: easy maintenance |

## Système de suivi (Moteurs, Programme, Capteurs)

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### 6) tracking system (engines, program, sensors)

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| Requirement | Demonstrator | Prototype | Comments for prototype |
|---|---|---|---|
| Real time accurate tracking of the sun motion | yes | yes | |
| Motorisation of mirrors | yes | yes | |
| Electricity consumption | - | Minimum achievable | Plan an autonomous working mode (no connection to electical grid)? (photovoltaic pannel?) |
| Number of engines | Minimum | One per module or one for all the system | To be validated regarding the other technical choices (structure) |
| Sun tracking to get the right angle | yes | yes, with necessary accuracy | Goal: send all the beams of each mirror on the width of the recptor (CPC width) |
| Sensors (weather condition detection) | - | yes | * ambiant temperature, direct sun radiation. (as a complement of process sensors (boiler and use)) |

| Requirement | Demonstrator | Prototype | Comments for prototype |
|---|---|---|---|
| Specific design for the working fluid, natural or forced circulation | 100% | yes | drive the circulating pump |
| Selective material: High absorption qualities through all the solar spectrum : 100%. Absorbance 90%, infrared emissivity 15% : material intrinsically absorbant (or absorptive coating) | = high absorbance through all the solar spectrum and low infrared emissivity | controlled by pressure and/or temperature (according to use). Steam flow rate sensor? Liquid water level sensor? ⇒ depends on type of use | |
| High thermal exchange between absorber and fluid | 60% | Safety in case of electrical outage (circulating pump stopped ⇒ temperature increase) + in case of a storm (mirrors down (if possible)). (Resistance to hail?) | material and conduction-convection in the fluid |
| The system should be thermally insulated (with respect to ambiant air, infrared radiation) | 60% | yes | see requirement for the overall thermal efficiency (insulation material above and glass below) |
| Good resistance to temperature variation (material expansion, tightness) | 60% | yes | In particular, risks related to high temperatures and pressure of fluid |
| Simple controlling panel | yes | Programming expert mode when needed, but simple to use | Ideas: remote access? consultation des informations de fonctionnement (et historique ?)To be scheduled |
| System automatic shutdown | Optional | yes | |

Ideas: * modularity is hardly compatible with the high constraints of the absorber (pressure, temperature variation etc.) * In case of frost, the absorber should be emptied (or the frost might destroy it). ⇒Ambiant temperature sensor + electric valve? ⇒design of the absorber enabling the complete emtying.

## Usage

Requirements to be better defined with user

Functioning

| Requirement | Demonstrator | Prototype | Comments for prototype |
|---|---|---|---|
| Position: avoid building shadow and other masks | - | ? | |
| Running range | - | ? | *for a sun exposure not in first hour nor in last hour, *for which hour range in the day, in the season, * for which latitude |
| Temperature level | - | ? | Optic and best technology may be different with respect to temperature. Example: *Hot water production at 80°C; *Steam production at 130°C from liquid water; *Steam Superheating from 150°C to 250°C |

#### Hydraulic circuit

| Requirement | Demonstrator | Prototype | Comments for prototype |
|---|---|---|---|
| Pressure losses | - | Minimum | Limit pressure losses, above all for light fluids : air, steam |
| Open/closed circuit | - | ? | |
| Mineral scale risks | - | ? | Gives good reason to run in a closed circuit... |
| Fluid | - | ? | |

Ideas: Could we have a feedback from the user? Which power (mini, maxi average) does he need? During how many hours? And for which season. At my parents', lavander distillery: July. Canned food and Jam from June to september.