Atmospheric Vapor Extraction Device

Concept Generation and Design

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Overview

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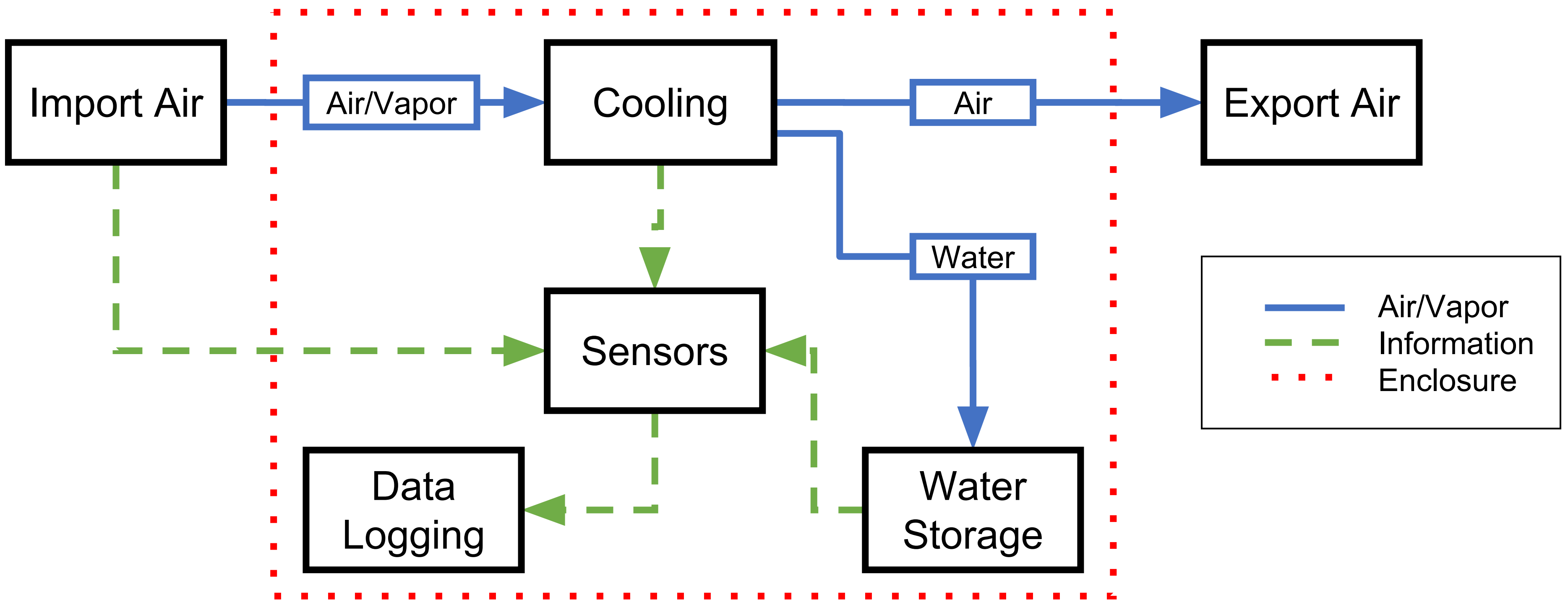
Introduction

- Mr. Chris Allender wants a device that measures the effectiveness of extracting water from air
- This device should have a maximum cost of $1,000 and also be portable enough for one person to transport
- The device must measure the atmospheric conditions and water produced

Functional Diagram



Criteria

Power Source

- Size
- Weight
- Initial Cost
- Running Cost
- Reliability
- Ease of Use

Analytical Hierarchy Process

Judgement of Preference	Numerical Rating
Extremely preferred	9
Very strongly preferred	7
Strongly preferred	5
Moderately preferred	3
Equally preferred	1

Power Source						
	Size	**Weight**	**Initial Cost**	**Running Cost**	**Reliability**	**Ease of Use**
Size	1	1/3	1/5	1/5	1/7	5
Weight	3	1	1/5	1/5	1/7	3
Initial Cost	5	5	1	3	3	5
Running Cost	5	5	1/3	1	1/3	3
Reliability	7	7	1/3	3	1	3
Ease of Use	1/5	1/3	1/5	1/3	1/3	1

Normalized Criteria

Power Source							
	Size	**Weight**	**Initial Cost**	**Running Cost**	**Reliability**	**Ease of Use**	**Rel. Weight**
Size	0.047	0.018	0.088	0.026	0.029	0.250	**8**
Weight	0.142	0.054	0.088	0.026	0.029	0.150	**8**
Initial Cost	0.236	0.268	0.441	0.388	0.606	0.250	**35**
Running Cost	0.236	0.268	0.147	0.129	0.067	0.150	**17**
Reliability	0.330	0.375	0.147	0.388	0.202	0.150	**27**
Ease of Use	0.009	0.018	0.088	0.043	0.067	0.050	**5**

Relative Weights

Power Source	
size	12
weight	16
initial cost	27
running cost	12
reliability	21
ease of use	12
	100

Sensors/Data Logger	
cost	13
reliability	29
accuracy	52
ease of use	6
	100

Relative Weights

Compressor	
initial cost	19
running cost	14
reliability	29
size	19
refrigerant type	19
	100

Condenser	
Cost	42
Efficiency (drip rate)	27
Size	15
Weight	16
	100

Concept Generation - Power Source

Source: bombayharbor.com

Source: batteryspace.com

Source: wastedspacer.weebly.com

Source: gajitz.com

Source: small-generator.com

Decision Matrix - Power Source

Performance Level	Value
Perfect	10
Excellent	9
Very Good	8
Good	7
Satisfactory	6
Adequate	5
Tolerable	4
Poor	3
Very Poor	2
Inadequate	1
Useless	0

	Wind	Solar panels	Generator	Outlet	Battery
Size	2.8	4.8	4.3	8.5	7.2
Weight	3.0	4.2	2.6	8.0	5.8
Initial Cost	4.2	4.2	4.3	8.0	5.5
Running Cost	6.5	7.5	3.3	5.8	6.0
Reliability	4.0	5.5	6.1	6.7	5.0
Ease of Use	3.3	4.8	5.4	8.0	7.5

Decision Matrix - Power Source

	Wind	Solar Panels	Generator	Outlet	Battery
Size	0.33	0.57	0.51	1.02	0.87
Weight	0.48	0.68	0.40	1.28	0.92
Initial cost	1.15	1.15	1.15	2.16	1.49
Running cost	0.78	0.90	0.39	0.69	0.72
Reliability	0.84	1.16	1.26	1.42	1.05
Ease of use	0.39	0.57	0.63	0.96	0.90
Total	3.97	5.02	4.34	$\boxed{7.53}$	5.95

Decision Matrix - Compressor

	DC Mini Compressor	DanFoss Mix	150W DC Tiny	Pro-Lift x3
Initial Cost	3.2	5.2	3.2	8.4
Running Cost	4.6	6.2	3.6	5.2
Reliability	5.6	6.6	4.4	3.4
Size	8	5	6.6	5.4
Refrigerant Type	5.6	6	5.2	0.6

Decision Matrix - Compressor

	DC Mini Compressor	DanFoss Mix	150W DC Tiny	Pro-Lift x3
Initial Cost	0.6	1.0	0.6	1.6
Running Cost	0.6	0.9	0.5	0.7
Reliability	1.6	1.9	1.3	1.0
Size	1.6	1.0	1.3	1.1
Refrigerant Type	1.0	1.1	0.9	0.1
Total	**5.5**	**5.9**	**4.6**	**4.5**

Decision Matrix Results

Components	Winning Model
Condenser	Plate Heat Exchanger
Evaporator	Plain coil design
Power Source	Outlet
Compressor	DanFoss Mix Refrigeration compressor
Sensors/Data Logger	Arduino based

Project Plan

	completed in progress coming	Weeks															
A	**Tasks**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	**Problem Definition and Project Plan**																
1.1	Need Statement																
1.2	Project Goals																
1.2.1	Objectives																
1.2.2	Constraints																
1.2.3	Quality Function Deployment																
1.2.3.1	Engineering Requirements																
1.2.3.2	Customer Requirements																
1.3	State Of The Art																
2	**Concept Generation and Selection**																
2.1	Functional Diagram																
2.2	concept generation																
2.3	criteria selection																
2.3.1	criteria weights																
2.4	Individual component selection																
2.4.1	filter through components																
2.5	Drawings																
2.6	Decision Matrix																
2.7	presentation preperation																
3	**Proof of Concept Demonstrations**																
3.1	Prototype assembly																
3.1.1	Test 1 design analysis data																
4	**Project Proposal**																
4.1	Economic analysis																
4.2	Proposal																
	Tasks Due Date																
	Problem Definition and Project Plan Presentations				**21-Sep**												
	Concept Generation and Selection Presentations								**19-Oct**								
	Proof of Concept Demonstrations												**16-Nov**				
	Project Proposal Presentations																**7-Dec**
	Final Report																**7-Dec**

Conclusion

- The Functional Diagram shows what features are needed
- Criteria are listed and ranked to show what is desired
- The different options are ranked based on the criteria
- Creating reliable and consistent data was top priority in a portable environment
- A refrigeration cycle is best to condense water out of the air
- The relative weights of the criteria allowed ranking of component importance

References

[1] Lee, Kang, and Ronald Wysk. "Miniature BLDC Refrigeration Compressor." (2011): 7. Web. 27 Oct. 2011. <http://www.appliancedesign.com/ext/resources/AM/Home/Files/PDFs/aspen_9-28-2011.pdf>.

[2] Glover, William. "Selecting Evaporators for Process Applications." 8 (2004). Web. 9 Dec. 2004. <http://www.lcicorp.com/assets/documents/CE_Evap_Selection.pdf>.