

Energy optimization control of extended-range hybrid combine harvesters based on quasi-cycle power demand estimation

Shuofeng Weng,^{1,2} Chaochun Yuan,^{3,4,5} Youguo He,³ Jie Shen,⁶ Lizhang Xu,^{4,5}
Zhihao Zhu,¹ Qiuye Yu,⁷ Xiaowei Yang³

¹School of Agricultural Engineering, Jiangsu University, Zhenjiang, China

²Faculty of Agricultural Engineering, Jiangsu University, Zhenjiang, China

³Automotive Engineering Research Institute, Jiangsu University, Zhenjiang, China

⁴Key Laboratory for Theory and Technology of Intelligent Agriculture Machinery and Equipment, Jiangsu University, Zhenjiang, China

⁵Jiangsu Province and Education Ministry Co-sponsored Synergistic Innovation Center of Modern Agricultural Equipment, Jiangsu University, Zhenjiang, China

⁶University of Michigan-Dearborn, Dearborn MI, USA

⁷China Automotive Technology & Research Center Co. Ltd., Tianjin, China

Corresponding authors:

Chaochun Yuan, Automotive Engineering Research Institute, Jiangsu University, No.301, Xuefu Road, Jingkou District, Zhenjiang, Jiangsu, 212013, China. E-mail:

yuancc_78@163.com

Qiuye Yu, China Automotive Technology & Research Center Co. Ltd., No. 3, Wanhui Road, Xiqing District, Tianjin, 300300, China. E-mail: yuqiuye@catarc.ac.cn

Key words: combines; hybrids; quasi-cycle processes; energy management strategy.

Appendix A

Key parameters of harvester

Table S1. Key parameters of harvester.

Parameter	Unit	Value
Overall dimensions (L×W×H)	mm	6500×3260×3450
Machine mass	kg	5740
Header working width	mm	2600
Minimum ground clearance	mm	350
Cutter type	-	Standard Type II
Feed rate	kg/s	9

Appendix B

Parameters of harvester system components and power units

Table S2. Parameters of harvester organs and motors.

	Rated Power (kW)	Motor Speed (rpm)	Motor Torque (Nm)	Gear Ratio	Gear Speed (rpm)	Gear Torque (Nm)
Conveyor motor	7.9	2500	30.18	5	500	150.88
Feeding auger motor	3.1	1000	11.84	4	250	47.36
Reel motor	3.1	1000	11.84	20	50	236.82
Axial fan motor	4	1500	15.28	No	1500	15.28
Vibration motor	11	2500	42.02	3	833	126.05
Crusher motor	11.3	3800	43.16	No	3800	43.16
Threshing cylinder motor	22	3000	70.03	5	600	350.17
Unloading auger Motor	7.5	1500	28.65	No	1500	28.65
Walking motor	22	3000	84.03	No	3000	84.03
Dust removal motor	5.2	2500	19.86	No	2500	19.86
Pump motor	2.5	3000	9.55	No	3000	9.55

Tables S3. Parameters of the generator and battery.

Component	Parameters	Units	Value
Generator	Maximum output power	kw	118
	Maximum output rotational speed	r/min	3000
	Voltage	V	540
Battery	Capacity	kwh	41
	Voltage	V	540
	Maximum charge current	A	156
	Maximum discharge current	A	156
	lower and upper limit of battery state of charge	/	20%, 100%

Appendix C

Parameters of the two engine models

Table S4. Parameters of the engines.

Parameters	Units	Diesel_100kW	YC-6B160Z
Number of engine cylinders	-	4	6
Engine rated power	kW	100	118
Engine rated speed	r/min	3000	2200
Max torque	Nm	350	580
Range of actual specific fuel consumption	g/kwh	277.3-1005.4	192.6-312.5