Crystal structure of (*E,E*)-4-hydroxy-3-methoxybenzaldehyde azine – a second polymorph, C₁₆H₁₆N₂O₄

Bonell Schmitt, Thomas I. A. Gerber, Eric C. Hosten and Richard Betz*

Nelson Mandela Metropolitan University, Summerstrand Campus, Department of Chemistry, University Way, Summerstrand, PO Box 77000, Port Elizabeth 6031, South Africa

Received May 15, 2014, accepted September 11, 2014, available online September 26, 2014, CCDC no. 1267/4169

Abstract

C₁₆H₁₆N₂O₄, monoclinic, *C*2/*c* (no. 15), *a* = 21.0239(4) Å, *b* = 21.0149(4) Å, *c* = 14.8104(3) Å, β = 107.607(1)°, *V* = 6236.9 Å³, *Z* = 16, *R*_g(*F*) = 0.0388, *wR*_{ref}(*F*²) = 0.1079, *T* = 200 K.

Table 1. Data collection and handling.

Crystal:	colourless blocks, size 0.136×0.205×0.366 mm
Wavelength:	Mo <i>K</i> _α radiation (0.71073 Å)
μ:	0.93 cm ^{−1}
Diffractometer, scan mode:	Bruker APEX-II CCD, φ and ω
2θ _{max} :	56.78°
<i>N</i> (<i>hkl</i>) _{measured} , <i>N</i> (<i>hkl</i>) _{unique} :	44411, 7788
Criterion for <i>I</i> _{obs} , <i>N</i> (<i>hkl</i>) _{gt} :	<i>I</i> _{obs} > 2 σ(<i>I</i> _{obs}), 5609
<i>N</i> (<i>param</i>) _{refined} :	405
Programs:	SHELX [4], WinGX [5], MERCURY [6], PLATON [7]

Source of material

The compound was obtained unintentionally upon the attempted coordination reaction of the title compound towards Re(CO)₅Br in toluene. Crystals suitable for the X-ray diffraction studies were obtained upon storing the reaction batch at 0 °C.

Experimental details

Carbon-bound H atoms were placed in calculated positions (C–H 0.95 Å for aromatic and vinylic carbon atoms) and were included in the refinement in the riding model approximation, with *U*_{iso}(H) set to 1.2*U*_{eq}(C). The H atoms of the methyl groups were allowed to rotate with a fixed angle around the C–C bond to best fit the experimental electron density (HFIX 137 in the SHELX program suite [6]), with *U*_{iso}(H) set to 1.5*U*_{eq}(C). The H atoms of the hydroxyl groups were allowed to rotate with a fixed angle around the C–O bond to best fit the experimental electron density (HFIX

147 in the SHELX program suite [6]), with *U*_{iso}(H) set to 1.5*U*_{eq}(O).

Discussion

Next to cardiovascular diseases, cancer has become one of the main fatal diseases in industrialized countries. Apart from classical surgery, chemo- and radiotherapeutic treatments have entered the arsenal of possible cures for certain types of cancer. All methods, however, suffer from their own set of problematic side-effects and, as a consequence, the development of radio-pharmaceuticals – combining the advantages of chemotherapy as well as radiation methods while at the same time avoiding their unique respective undesired side-effects – has been a topic of research [1]. Tailoring and fine-tuning of the envisioned radio-pharmaceuticals' properties such as lipophilicity and, in particular, inertness is of paramount importance with respect to possible future *in vivo* applications in contemporary medicine and requires sound knowledge about structural parameters of the ligands applied if a more heuristic approach in the synthesis is to triumph over pure trial-and-error as it is encountered in this specific field of coordination chemistry up to the present day. In continuation of our study of rhenium-based coordination compounds that might serve as radiopharmaceuticals, the coordination of the title compound to a rhenium(I) starting material was attempted. A diffraction study of the isolated crystalline reaction product showed the ligand to be retrieved, however, as a new polymorph. Structural data about the first polymorph is available in the literature [2]. The asymmetric unit contains one complete and two half molecules of the title compound. All molecules are essentially flat (r.m.s. of all fitted non-hydrogen atoms = 0.4668 Å, 0.4862 Å and 0.5108 Å). The least-squares planes as defined by the non-hydrogen atoms of the respective aromatic moieties on the one hand as well as the connecting azine bridge on the other hand in the complete molecule of the asymmetric unit intersect at angles of 22.23(7)° and 22.64(12)°. All C=N bonds are *E*-configured, their lengths covering a range of 1.2727(17)–1.2746(17) Å. The values for the respective N–N bonds were found in between 1.4128(19) Å and 1.415(2) Å. All these lengths are in good agreement with values reported for similar compounds featuring a –CC(H)=N–N=C(H)C– moiety whose structural data has been deposited with the Cambridge Structural Database [3]. While the C=N bond lengths are invariably shorter than the ones found in the other polymorph of the title compound [2], the opposite holds true for the respective N–N bond lengths [2]. In the crystal, intermolecular hydrogen bonds of the O–H⋯N type are observed. These connections form a layered structure parallel to the *ab* plane.

* Correspondence author (e-mail: Richard.Betz@nmmu.ac.za)

Table 2. Atomic coordinates and displacement parameters (in Å²).

Atom	Site	<i>x</i>	<i>y</i>	<i>z</i>	<i>U</i> _{iso}
H(14)	8 <i>f</i>	0.0346	0.7796	0.1581	0.067
H(24)	8 <i>f</i>	0.0776	0.0961	0.3350	0.070
H(1)	8 <i>f</i>	0.0209	0.4700	0.1234	0.041
H(2)	8 <i>f</i>	0.0927	0.4054	0.3765	0.043
H(12)	8 <i>f</i>	0.1103	0.5929	0.2806	0.039
H(15)	8 <i>f</i>	−0.0463	0.6690	0.0059	0.049
H(16)	8 <i>f</i>	−0.0338	0.5600	0.0325	0.047
H(17A)	8 <i>f</i>	0.1352	0.6743	0.3909	0.080
H(17B)	8 <i>f</i>	0.1791	0.7358	0.3865	0.080
H(17C)	8 <i>f</i>	0.1891	0.6715	0.3344	0.080
H(22)	8 <i>f</i>	0.0827	0.2831	0.2020	0.039
H(25)	8 <i>f</i>	0.0937	0.2059	0.5023	0.051
H(26)	8 <i>f</i>	0.0950	0.3151	0.4767	0.050
H(27A)	8 <i>f</i>	0.0473	0.2025	0.0921	0.084
H(27B)	8 <i>f</i>	0.0862	0.1384	0.0837	0.084
H(27C)	8 <i>f</i>	0.1271	0.2006	0.1299	0.084

Table 2. continued.

Atom	Site	<i>x</i>	<i>y</i>	<i>z</i>	<i>U</i> _{iso}
H(34)	8 <i>f</i>	0.3237	−0.0081	0.1642	0.069
H(3)	8 <i>f</i>	0.0058	−0.0089	0.1242	0.042
H(32)	8 <i>f</i>	0.1632	0.0373	0.2895	0.040
H(35)	8 <i>f</i>	0.1798	−0.0471	0.0055	0.050
H(36)	8 <i>f</i>	0.0759	−0.0396	0.0306	0.048
H(37A)	8 <i>f</i>	0.2576	0.0988	0.3557	0.088
H(37B)	8 <i>f</i>	0.3319	0.0731	0.4035	0.088
H(37C)	8 <i>f</i>	0.2693	0.0291	0.4013	0.088
H(44)	8 <i>f</i>	0.1395	0.3806	0.1562	0.071
H(4)	8 <i>f</i>	0.4410	0.3763	0.1204	0.040
H(42)	8 <i>f</i>	0.3529	0.3392	0.2879	0.038
H(45)	8 <i>f</i>	0.2164	0.4121	−0.0049	0.050
H(46)	8 <i>f</i>	0.3310	0.4027	0.0219	0.048
H(47A)	8 <i>f</i>	0.2846	0.2726	0.3442	0.083
H(47B)	8 <i>f</i>	0.2310	0.2961	0.3940	0.083
H(47C)	8 <i>f</i>	0.2939	0.3399	0.3972	0.083

Table 3. Atomic coordinates and displacement parameters (in Å²).

Atom	Site	<i>x</i>	<i>y</i>	<i>z</i>	<i>U</i> ₁₁	<i>U</i> ₂₂	<i>U</i> ₃₃	<i>U</i> ₁₂	<i>U</i> ₁₃	<i>U</i> ₂₃
O(13)	8 <i>f</i>	0.10701(5)	0.71885(4)	0.26738(7)	0.0455(6)	0.0299(5)	0.0455(5)	−0.0005(4)	−0.0028(4)	−0.0012(4)
O(14)	8 <i>f</i>	0.01590(5)	0.75906(4)	0.10854(7)	0.0587(6)	0.0357(5)	0.0356(5)	0.0075(4)	0.0091(4)	0.0035(4)
O(23)	8 <i>f</i>	0.08349(5)	0.15678(4)	0.21320(7)	0.0657(7)	0.0312(5)	0.0394(5)	−0.0004(4)	0.0204(5)	−0.0007(4)
O(24)	8 <i>f</i>	0.08820(6)	0.11622(4)	0.38644(7)	0.0616(7)	0.0357(5)	0.0394(5)	−0.0015(5)	0.0105(5)	0.0078(4)
N(1)	8 <i>f</i>	0.08460(5)	0.47134(5)	0.24723(8)	0.0287(5)	0.0279(5)	0.0507(7)	−0.0021(4)	0.0138(5)	−0.0052(5)
N(2)	8 <i>f</i>	0.08307(5)	0.40413(5)	0.24354(8)	0.0293(5)	0.0279(5)	0.0514(7)	−0.0013(4)	0.0139(5)	−0.0045(5)
C(1)	8 <i>f</i>	0.04636(6)	0.49700(6)	0.17247(9)	0.0300(6)	0.0343(6)	0.0415(7)	−0.0045(5)	0.0147(5)	−0.0071(5)
C(2)	8 <i>f</i>	0.08853(6)	0.37848(6)	0.3234(1)	0.0262(6)	0.0357(7)	0.0458(7)	−0.0013(5)	0.0124(5)	−0.0058(6)
C(11)	8 <i>f</i>	0.03971(6)	0.56529(6)	0.15845(9)	0.0288(6)	0.0336(6)	0.0374(6)	−0.0010(5)	0.0144(5)	−0.0035(5)
C(12)	8 <i>f</i>	0.07862(6)	0.60830(6)	0.22461(9)	0.0258(6)	0.0335(6)	0.0377(6)	0.0021(5)	0.0092(5)	−0.0006(5)
C(13)	8 <i>f</i>	0.07126(6)	0.67264(6)	0.20896(9)	0.0277(6)	0.0331(6)	0.0349(6)	−0.0001(5)	0.0104(5)	−0.0022(5)
C(14)	8 <i>f</i>	0.02398(6)	0.69591(6)	0.12663(9)	0.0378(7)	0.0333(6)	0.0329(6)	0.0046(5)	0.0150(5)	0.0025(5)
C(15)	8 <i>f</i>	−0.01445(7)	0.65356(7)	0.06177(9)	0.0427(8)	0.0457(8)	0.0301(6)	0.0038(6)	0.0057(6)	0.0018(5)
C(16)	8 <i>f</i>	−0.00687(7)	0.58877(7)	0.07752(9)	0.0402(7)	0.0429(7)	0.0338(7)	−0.0038(6)	0.0094(6)	−0.0065(6)
C(17)	8 <i>f</i>	0.15644(8)	0.69853(7)	0.3513(1)	0.0503(9)	0.0397(8)	0.0529(9)	−0.0045(7)	−0.0097(7)	−0.0002(7)
C(21)	8 <i>f</i>	0.08870(6)	0.31005(6)	0.33728(9)	0.0251(6)	0.0340(6)	0.0426(7)	−0.0007(5)	0.0114(5)	−0.0023(5)
C(22)	8 <i>f</i>	0.08536(6)	0.26740(6)	0.26323(9)	0.0281(6)	0.0329(6)	0.0366(6)	−0.0007(5)	0.0108(5)	0.0022(5)
C(23)	8 <i>f</i>	0.08593(6)	0.20298(6)	0.27894(9)	0.0287(6)	0.0334(6)	0.0355(6)	−0.0004(5)	0.0096(5)	−0.0011(5)
C(24)	8 <i>f</i>	0.08843(6)	0.17958(6)	0.36880(9)	0.0313(6)	0.0348(6)	0.0380(7)	0.0000(5)	0.0079(5)	0.0059(5)
C(25)	8 <i>f</i>	0.09175(7)	0.22156(7)	0.4413(1)	0.0453(8)	0.0495(8)	0.0331(7)	−0.0018(6)	0.0110(6)	0.0032(6)
C(26)	8 <i>f</i>	0.09223(7)	0.28645(7)	0.4260(1)	0.0415(8)	0.0438(8)	0.0404(7)	−0.0020(6)	0.0143(6)	−0.0076(6)
C(27)	8 <i>f</i>	0.0862(1)	0.17608(7)	0.1227(1)	0.088(1)	0.0434(8)	0.0444(8)	0.0003(8)	0.0319(8)	−0.0026(7)
O(33)	8 <i>f</i>	0.28704(5)	0.03549(5)	0.27801(7)	0.0281(5)	0.0633(6)	0.0461(5)	−0.0055(4)	0.0124(4)	−0.0109(5)
O(34)	8 <i>f</i>	0.29256(5)	−0.01340(5)	0.11355(7)	0.0327(5)	0.0668(7)	0.0403(5)	0.0082(5)	0.0151(4)	0.0046(5)
N(3)	8 <i>f</i>	0.03402(5)	0.02217(5)	0.25183(8)	0.0252(5)	0.0307(5)	0.0510(7)	−0.0003(4)	0.0127(5)	0.0003(5)
C(3)	8 <i>f</i>	0.04349(6)	0.00338(6)	0.17521(9)	0.0285(6)	0.0302(6)	0.0431(7)	0.0000(5)	0.0078(5)	0.0029(5)
C(31)	8 <i>f</i>	0.10903(6)	−0.00020(6)	0.16189(9)	0.0288(6)	0.0292(6)	0.0420(7)	0.0020(5)	0.0107(5)	0.0045(5)
C(32)	8 <i>f</i>	0.16652(6)	0.02047(6)	0.23160(9)	0.0311(6)	0.0308(6)	0.0400(7)	0.0009(5)	0.0134(5)	−0.0013(5)
C(33)	8 <i>f</i>	0.22782(6)	0.01638(6)	0.21633(9)	0.0274(6)	0.0318(6)	0.0394(7)	0.0004(5)	0.0085(5)	0.0024(5)
C(34)	8 <i>f</i>	0.23300(6)	−0.00921(6)	0.13127(9)	0.0315(6)	0.0367(7)	0.0393(7)	0.0067(5)	0.0149(5)	0.0081(5)
C(35)	8 <i>f</i>	0.17646(7)	−0.02977(7)	0.0631(1)	0.0406(8)	0.0496(8)	0.0348(7)	0.0052(6)	0.0119(6)	0.0008(6)
C(36)	8 <i>f</i>	0.11472(7)	−0.02532(7)	0.0781(1)	0.0328(7)	0.0446(8)	0.0390(7)	0.0019(6)	0.0065(6)	0.0023(6)
C(37)	8 <i>f</i>	0.28640(8)	0.06109(9)	0.3665(1)	0.0398(8)	0.083(1)	0.0539(9)	−0.0146(8)	0.0151(7)	−0.0247(9)
O(43)	8 <i>f</i>	0.22380(4)	0.33969(5)	0.27286(7)	0.0266(5)	0.0665(7)	0.0436(5)	0.0056(4)	0.0118(4)	0.0130(5)
O(44)	8 <i>f</i>	0.14925(4)	0.38506(5)	0.10558(7)	0.0266(5)	0.0701(7)	0.0401(5)	0.0069(4)	0.0036(4)	0.0008(5)
N(4)	8 <i>f</i>	0.46671(5)	0.35243(5)	0.25138(8)	0.0261(5)	0.0311(5)	0.0466(6)	−0.0004(4)	0.0141(5)	−0.0008(5)
C(4)	8 <i>f</i>	0.42472(6)	0.36714(6)	0.17223(9)	0.0318(6)	0.0293(6)	0.0422(7)	−0.0004(5)	0.0152(5)	−0.0002(5)
C(41)	8 <i>f</i>	0.35336(6)	0.37057(6)	0.15728(9)	0.0301(6)	0.0280(6)	0.0393(7)	0.0007(5)	0.0108(5)	−0.0014(5)
C(42)	8 <i>f</i>	0.32514(6)	0.35336(6)	0.22802(9)	0.0276(6)	0.0301(6)	0.0354(6)	0.0023(5)	0.0066(5)	0.0003(5)
C(43)	8 <i>f</i>	0.25733(6)	0.35690(6)	0.21110(9)	0.0279(6)	0.0325(6)	0.0352(6)	0.0008(5)	0.0092(5)	−0.0014(5)
C(44)	8 <i>f</i>	0.21620(6)	0.37984(6)	0.12379(9)	0.0265(6)	0.0375(7)	0.0384(7)	0.0026(5)	0.0039(5)	−0.0051(5)
C(45)	8 <i>f</i>	0.24406(7)	0.39681(7)	0.05433(9)	0.0380(7)	0.0490(8)	0.0335(7)	0.0056(6)	0.0043(6)	0.0033(6)
C(46)	8 <i>f</i>	0.31225(7)	0.39166(7)	0.0706(1)	0.0387(7)	0.0431(7)	0.0395(7)	0.0028(6)	0.0139(6)	0.0033(6)
C(47)	8 <i>f</i>	0.26122(7)	0.30970(9)	0.3588(1)	0.0372(8)	0.080(1)	0.0496(9)	0.0059(7)	0.0142(7)	0.0216(8)

Acknowledgments. The authors thank Mr Jason Mather for helpful discussions.

References

1. Potgieter, K. C.; Gerber, T. I. A.; Betz, R.; Rhyman, L.; Ramasami, P.: Structural and DFT/TD-DFT investigation of *tris*(bidentate) complexes of rhenium(III) synthesized from the *cis*-[ReO₂]⁺ core and benzenethiol derivatives. *Polyhedron*. **59** (2013) 91–100.
2. Qu, Y.; Sun, X.-M.: (*E,E*)-4-hydroxy-3-methoxybenzaldehyde azine. *Acta Crystallogr.* **E61** (2005) o3828–o3830.
3. Allen, F. H.: The Cambridge Structural Database: a quarter of a million crystal structures and rising. *Acta Crystallogr.* **B58** (2002) 380–388.
4. Sheldrick, G. M.: A short history of SHELX. *Acta Crystallogr.* **A64** (2008) 112–122.
5. Farrugia, L. J.: WinGX and ORTEP for Windows: an update. *J. Appl. Crystallogr.* **45** (2012) 849–854.
6. Macrae, C. F.; Bruno, I. J.; Chisholm, J. A.; Edgington, P. R.; McCabe, P.; Pidcock, E.; Rodriguez-Monge, L.; Taylor, R.; van de Streek, J.; Wood, P. A.: Mercury CSD 2.0 – new features for the visualization and investigation of crystal structures. *J. Appl. Crystallogr.* **41** (2008) 466–470.
7. Spek, A. L.: Structure validation in chemical crystallography. *Acta Crystallogr.* **D65** (2009) 148–155.